TOMOLOGY LIBRARY
- 4 AUG 1959
RIAL AS. 25
PARATE
E & A.

Vol. XLII MARCH, 1959 No. 10

THE PHILIPPINE AGRICULTURIST

JOURNAL OF THE COLLEGE OF AGRICULTURE
AND CENTRAL EXPERIMENT STATION
University of the Philippines

CONTENTS

Zonal Structure of the Shoot Apex of *Oryza sativa* L. ..... *Prescillano M. Zamora* 391

Effect of Spacing Upon the Yield of Tick Clover [*Desmodium intortum* (Mill.) Urb.] ..... *V. C. Calma, F. O. Valera and F. I. Santos* 404

"Inert" Dusts for the Control of Storage Insects of Shelled Corn ..... *G. B. Viado and R. M. Labadan* 414

A Survey of Naric Warehouses in Luzon with Reference to the Control of Stored Grain Insects ..... *R. M. Labadan and G. B. Viado* 423

Marketing Corn at the Farm Level in the Philippines ..... *Benjamin D. Peredo* 431

Note:

Crossing the Common and Scarlet Bean (*Phaseolus* SPP) with Vigna Species ..... *F. B. Ballon and T. L. York* 454

UNIVERSITY OF THE PHILIPPINES PUBLICATIONS SERIES A
Published at College, Laguna

The Philippine Agriculturist

Journal of the College of Agriculture and Central Experiment Station
University of the Philippines

EDITORIAL STAFF

J. R. VELASCO, Editor
G. D. FELICIANO, Associate Editor
J. M. CAPINPIN, Business Manager
G. B. VIADO, Animal Sciences
J. BANZON, Physical Sciences
D. L. UMALI, Plant Sciences
G. F. SAGUIGUIT, Social Sciences
A. D. YÑIGUEZ, Statistics

ADMINISTRATIVE STAFF

L. B. UICHANCO ..... Dean
F. O. SANTOS ..... Assistant Dean
J. M. CAPINPIN ..... Head, Department of Agricultural Botany
L. J. VILLANUEVA ..... Acting Head, Department of Agricultural Chemistry
P. R. SANDOVAL ..... In Charge, Department of Agricultural Economics
M. V. JARMIN ..... Acting Head, Department of Agricultural Education
A. B. CATAMBAY ..... Head, Department of Agricultural Engineering
V. C. CALMA ..... Head, Department of Agronomy
A. C. CAMPOS ..... Acting Head, Department of Animal Husbandry
S. M. CENDAÑA ..... Head, Department of Entomology
N. R. BUSTRILLOS ..... In Charge, Department of Home Technology
E. C. LEGASPI ..... Head, Department of Languages
F. T. ORILLO ..... Head, Department of Plant Pathology
N. L. GALVEZ ..... Head, Department of Soils

THE PHILIPPINE AGRICULTURIST is published monthly except in April and May by the College of Agriculture and Central Experiment Station, University of the Philippines, College, Laguna. The subscription price is ₱6.00 a year in the Philippines and $4.00 (U.S. currency) elsewhere; the price of single copies, ₱0.75 in the Philippines and $0.50 elsewhere.

Authors of articles appearing in THE PHILIPPINE AGRICULTURIST are severally responsible for the opinions expressed therein.

Publications sent in exchange for THE PHILIPPINE AGRICULTURIST should be addressed to the Library of the College of Agriculture and Central Experiment Station, University of the Philippines.

Entered at the Post Office at College, Laguna, Philippines, as second-class mail matter.

ZONAL STRUCTURE OF THE SHOOT APEX OF *ORYZA SATIVA* L.[1]

PRESCILLANO M. ZAMORA

WITH FIVE TEXT FIGURES

The apical architecture of the Elon-elon variety of rice (*Oryza sativa* L.) is described in the light of the tunica-corpus concept and the cyto-histological zonation of the corpus. The shoot apex of this variety is composed of a biseriate tunica and a zonated corpus. The corpus has three distinct regions or zones, namely: the zone of corpus initials situated at the summit of the corpus tissue; the zone of file meristem which occupies the central region of the corpus subjacent to the zone of corpus initials from which it is derived; and the zone of peripheral meristem derived laterally from the zone of corpus initials and which surrounds the file meristem. The component cells of these zones differ in their direction of division, degree of vacuolation, and staining quality of their contents.

The organization of the shoot apex of some species of grasses has been interpreted, in recent years, in accordance with the tunica-corpus concept and the cyto-histological zonation of the corpus. The vegetative shoot apex of *Oryza,* however, has not been studied and defined with reference to these concepts. Published accounts on the shoot apex of this crop plant are confined to the determination of the number of tunica layers in the apical meristem.

The present investigation is concerned with the interpretation of the shoot apex of *Oryza* within the limitations imposed by fixed and killed materials, in the light of the foregoing concepts. Results will be utilized subsequently as background for interpreting future studies on the shoot apex of *Oryza* relative to mineral nutrition, photoperiodic treatments, effects of growth-regulating substances, effects of x-radiation, morphogenesis, and comparative morphology.

MATERIALS AND METHODS

Vegetative shoot apices [2] of the Elon-elon variety of *Oryza sativa* L. were used. The apical meristems were dissected from the

[1] Central Experiment Station Contribution No. 2000. The writer wishes to thank Dr. Jose R. Velasco for his helpful suggestions in the preparation of this paper.

[2] Taken from control plants at different stages of growth of a photoperiodic experiment being conducted in the Department of Agricultural Botany.

surrounding leaves, fixed in formalin-acetic-alcohol, dehydrated through the tertiary butyl alcohol series (Johansen, 1940), and embedded in "Tissue Mat." Serial sections were "microtomed" at a thickness of 10 to 11 microns and stained with the following: Delafield's hematoxylin (Johansen, 1940); Delafield's hematoxylin and safranin (Boke, 1939); tannic acid-iron alum with safranin (Sharman, 1943b); tannic acid-ferric chloride (Foster, 1934); safranin and fast green (Johansen, 1940). Suggestions given by Ball (1941) and Cross (1936) for the preparation of shoot apices proved helpful in this work.

OBSERVATIONS

Size and form of the shoot apex. The term "shoot apex" in this investigation is restricted to that portion of the apical meristem distal to the latest leaf primordium formed. The criteria used in delimiting the extent of the shoot apex were the presence of a convex bulge on the flank of the apical meristem with the accompanying periclinal walls in the tunica layers (*Li*, fig. 4), and the presence of a periclinal wall or walls in the outer tunica layer alone (*Li*, figs. 2 and 3).

The shoot apex assumed the form of a dome (figs. 1, 2, 3, and 4) similar to that commonly found in most grasses. It was 239.58 microns broad and 138.88 microns high. These data were the averages of individual measurements of median and near-median longitudinal sections of twenty shoot apices (table 1). Measurements were

TABLE 1.—*Size of shoot apices of rice plants in four stages of growth*

AGE IN DAYS	NUMBER OF APICES	HEIGHT IN MICRONS	BREADTH IN MICRONS
48	8	126.12	238.69
51	5	144.44	235.42
55	3	141.90	268.52
60	4	143.08	215.68
Total	20	555.54	958.31
Average	5	138.88	239.58

made above the level of the youngest leaf primordia. Previous workers gave no measurements for the shoot apex of rice. The size of the apex varies with the age or stage of development of the rice plants. A study of the shoot apex of rice relative to each plasto-

chron is in progress and the observations will be presented in a separate paper.

Apical meristem. The observations presented in this paper were based on 24 median or near-median longitudinal sections of shoot apices cut in the plane of the leaves. Figures 1, 2, 3, and 4 are radial longitudinal views of the apices of plants at four stages of growth. As is shown in the figures, the superficial tissue of the apical meristem is composed of approximately rectangular and polygonal cells which divide characteristically anticlinally except at the point of initiation of foliar primordia down the flanks of the apical mound (*Li*, figs. 2, 3, and 4), and form discrete sheet of cells overlying and independent of the cells below them. There are invariably two distinct layers of cells in this tissue. The outer layer is designated *To* and the inner layer *Ti*. They constitute the tunica of the apical meristem of this rice variety. The bold lines delimit the layers from each other and from the tissue enclosed by them below. The cells on the summit of the apical dome stain rather lightly and appear tangentially stretched in longitudinal sections. They divide rather infrequently and it is often possible to recognize three or five large and centrally located cells in the apex. These are the initial cells from which the two superficial layers are derived. The tunica cells on the flanks are oriented with their long axes at right angles to the surface. This is especially apparent on and above the axils of the developing leaf (left flank of the shoot apex in figs. 1, 2, 3 and 4; *La*, fig. 5). The cells appear highly meristematic and densely stained in preparations.

Within the superficial layers of cells or tunica described in the preceding paragraph is enclosed a central core of meristem, the corpus. Examination of many median longitudinal sections of the shoot apex showed that the cells of the corpus differ in their method of division, degree of vacuolation, and staining quality of their contents. Such differences make possible the division of the corpus into regions or zones.

The summit of the corpus is occupied by an approximately lens-shaped tissue which is generally two to four cells deep (*Ca*, figs. 1, 2, 3 and 4). This constitutes zone 1 of the corpus. The nuclei of the cells are included in the figures to distinguish them from the rest of the cells in the meristem. The cells were observed to be similar in histological characteristics to the superficial initial cells overlying them in the apical meristem.

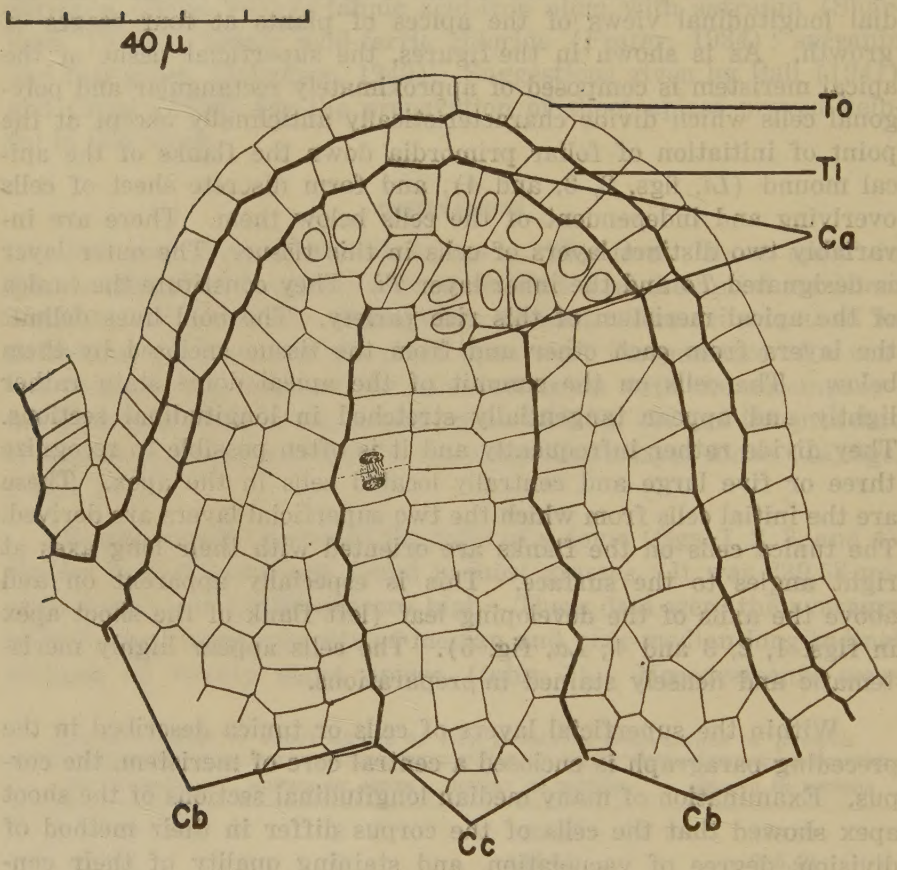

Fig. 1.—Median longitudinal view of the shoot apex of a 51-day-old rice plant showing the biseriate tunica and the zonated corpus. *To*, outer tunica layer; *Ti*, inner tunica layer; *Ca*, corpus initial zone; *Cb*, peripheral meristem; *Cc*, file meristem.

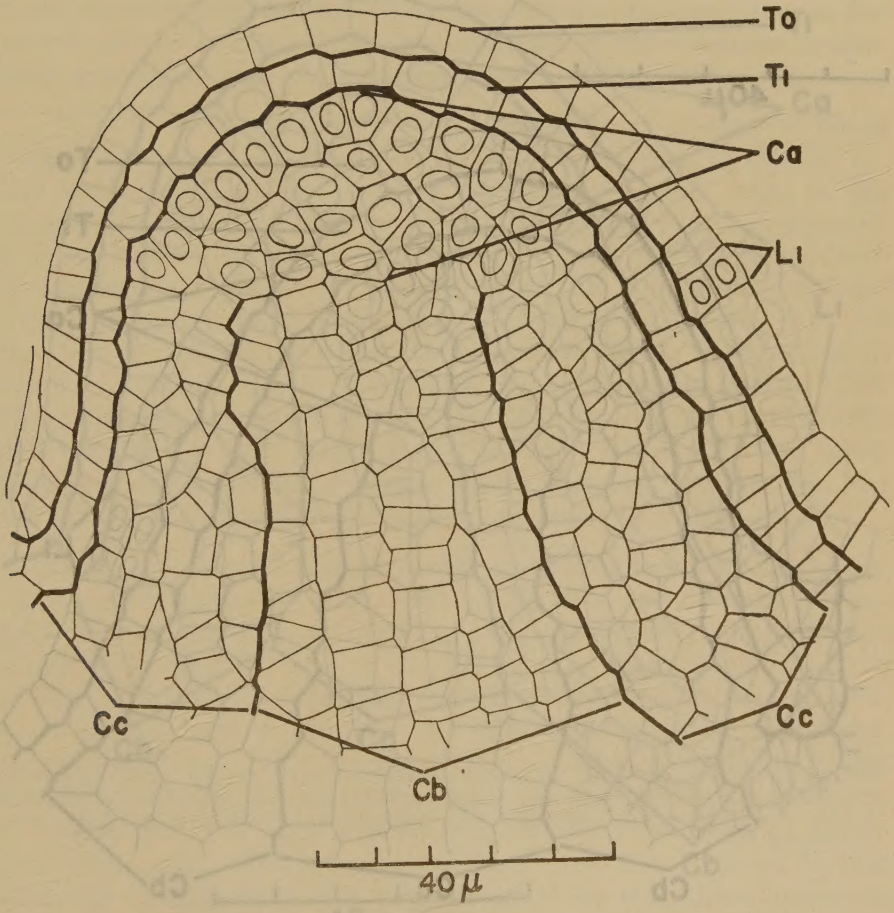

Fig. 2.—Median longitudinal view of the shoot apex of a 55-day-old rice plant showing the biseriate tunica, zonated corpus, and a periclinally divided cell of the outer tunica layer on the right flank of the apical meristem. *To*, outer tunica layer; *Ti*, inner tunica layer; *Ca*, corpus initial zone; *Cb*, file meristem; *Cc*, peripheral meristem; *Li*, division that initiates the leaf primordium.

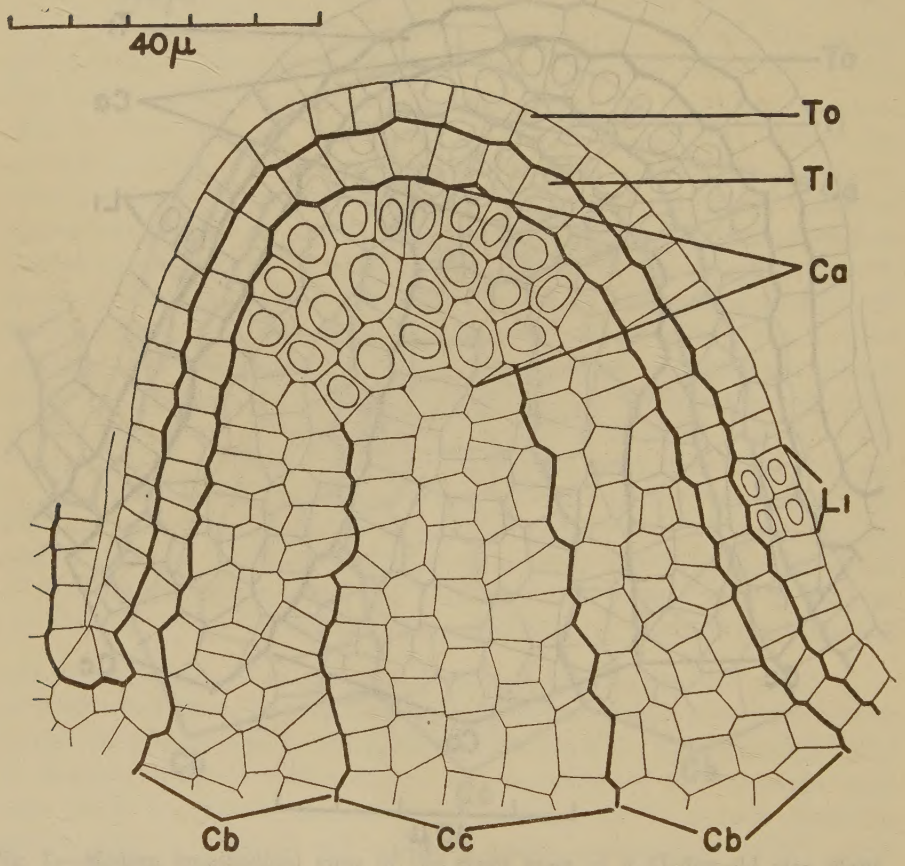

Fig. 3.—Median longitudinal view of the shoot apex of a 60-day-old rice plant showing the biseriate tunica, zonated corpus, and periclinally divided cells of the outer tunica layer.

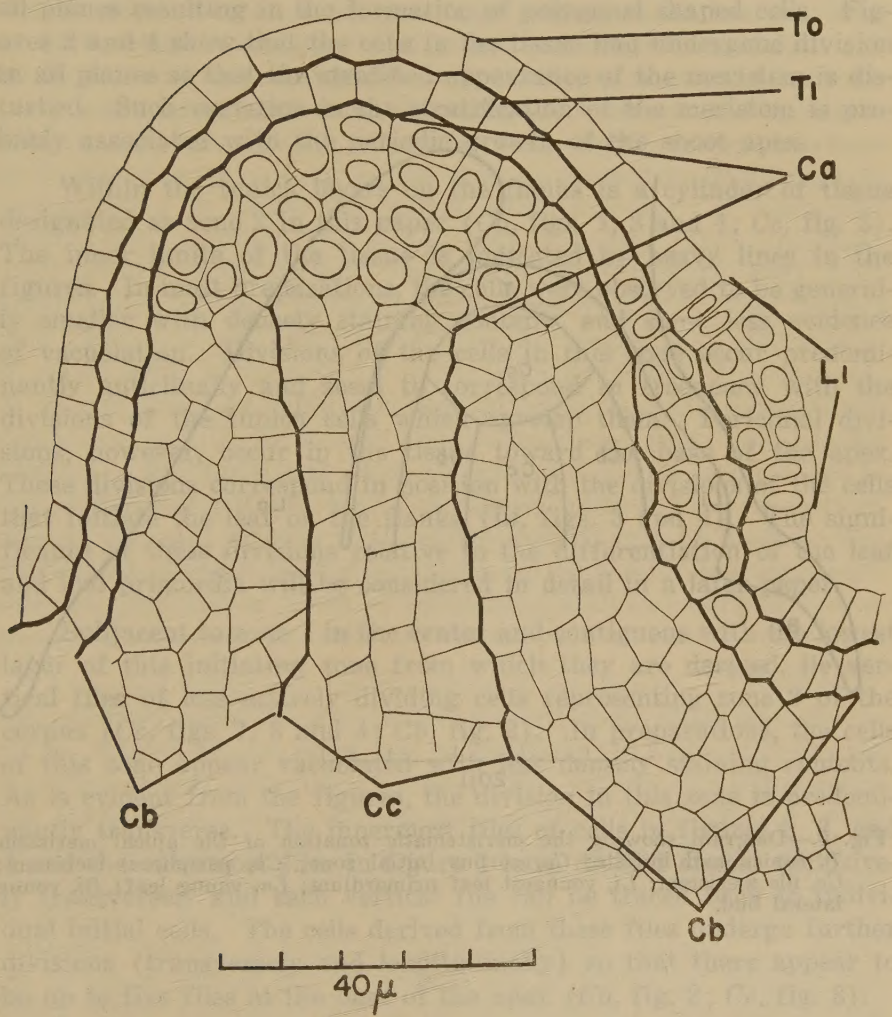

Fig. 4.—Median longitudinal view of the shoot apex of a 48-day-old rice plant showing the biseriate tunica, zonated corpus, and a slight bulge on the right flank of the apical meristem resulting from the periclinal and anticlinal divisions of the outer and inner tunica layers. *To*, outer tunica layer; *Ti*, inner tunica layer; *Ca*, corpus initial zone; *Cb*, peripheral meristem; *Cc*, file meristem; *Li*, early stages of development of the leaf primordium.

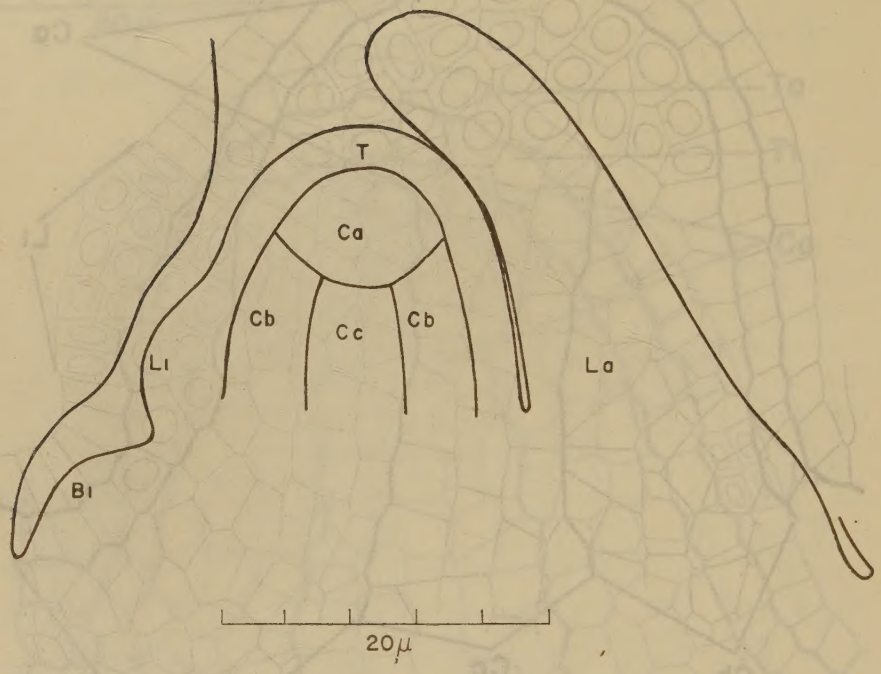

Fig. 5.—Diagram showing the meristematic zonation of the apical meristem. *T*, tunica and initials; *Ca*, corpus initial zone; *Cb*, peripheral meristem; *Cc*, file meristem; *Li*, youngest leaf primordium; *La*, young leaf; *Bi*, young lateral bud.

Often, the cells divide predominantly anticlinally so that the meristem exhibits a more or less stratified appearance (*Ca,* figs. 1 and 3). In most instances, however, the cells divide irregularly and in all planes resulting in the formation of polygonal shaped cells. Figures 2 and 4 show that the cells in the tissue had undergone division in all planes so that the stratified appearance of the meristem is disturbed. Such variation in the stratification of the meristem is probably associated with the periodic growth of the shoot apex.

Within the tunica layers on the flanks is a cylinder of tissue designated as zone 2 in this paper (*Cb,* figs. 1, 3 and 4; *Cc,* fig. 2). The inner limits of the tissue is indicated by heavy lines in the figures. In most preparations, the cells were observed to be generally smaller with densely staining contents and show less evidence of vacuolation. Divisions of the cells in this zone occur predominantly anticlinally and seem to correspond in frequency with the divisions of the tunica cells which envelop them. Periclinal divisions, however, occur in the tissue toward the base of the apex. These divisions correspond in position with the divisions of the cells that initiate the leaf on the flanks (*Li,* figs. 3 and 4). The significance of these divisions relative to the differentiation of the leaf and bud primordia will be considered in detail in a later paper.

Subjacent to zone 1 in the center and contiguous with the lowest layer of this initiating zone from which they are derived, lie vertical files of less actively dividing cells representing zone 3 of the corpus (*Cc,* figs. 1, 3 and 4; *Cb,* fig. 2). In preparations, the cells of this zone appear vacuolated with less densely staining contents. As is evident from the figures, the division in this zone is predominantly transverse. The innermost files of cells in figures 2, 3, and 4 and the outermost files in figure 1 have divided almost exclusively transversely and each vertical file can be traced back to individual initial cells. The cells derived from these files undergo further divisions (transversely and longitudinally) so that there appear to be up to five files at the base of the apex (*Cb,* fig. 2; *Cc,* fig. 3).

Figure 5 shows diagrammatically the positions of the tunica and the zonated corpus of the apical meristem in relation to the developing leaves and bud. The figure corresponds to the stage of development reached by the shoot apex illustrated in figure 4.

DISCUSSION

The shoot apex of *Oryza sativa* L. was reported to have one

tunica layer by Douliot (1891), Brown, Heimsch, and Emery (1957), and two tunica layers by Thielke (1951), Brown, Heimsch, and Emery (1957). This disagreement on the number of tunica layers in *Oryza* and other grasses may stem from at least three causes: (1) differing concepts or criteria by which tunica layers were recognized (Brown *et al.*, 1957); (2) changes in stratification of the corpus as a consequence of temporary developmental sequence (Zimmermann, 1928; Kliem, 1937; Schnabel, 1941); and (3) periodic changes in stratification of the tunica as the apex passes from "maximal" to "minimal" area during the course of a plastochron (Schmidt, 1924; Schnabel, 1941; Cross and Johnson, 1941; Reeve, 1942, 1948; Gifford, 1950; Rouffa and Gunckel, 1951; Sussex, 1955; Cutter, 1955). The present writer observed that the apical meristem of this rice variety has two well-defined tunica layers. This observation is remarkable for while the number of such layers in many plants is reported to fluctuate in relation to the foregoing attribute, the tunica layers remained constant in all the four stages of development of the rice plant studied. It is tempting to propose, in view of the foregoing observation, that the biseriate tunica is a basic feature of organization of the shoot apex of this rice variety. Developmental studies on the shoot apex, from seedling to inflorescence formation, are being conducted in order to determine whether a biseriate tunica is also present in other development phases of the rice plant.

Periclinal divisions independent of the initiation of foliar primordia have not been observed at any point on the summit of the tunica region in *Oryza*. The tunica appeared as double unbroken layers of anticlinally dividing cells over the apex. Hsu (1944) also observed that such divisions are absent in *Sinocalamus* (a bamboo). These observations do not, however, entirely rule out the possibility that periclinal divisions may also occur in the apical meristems of *Oryza*. In contrast, periclinal divisions occur in varying frequency and without regularity in the summit of the tunica layers of the lateral buds and main shoot apices of *Zea* (Sharman, 1940; Ledin, 1954), *Agropyron* (Sharman, 1943a, 1945), *Chlorogalum* (Sterling, 1944), and *Triticum* (Sharman, 1945). The occurrence of such divisions in apices is certainly a reflection of the dynamic nature of expanding shoots and must not be considered as a distinct feature of organization.

The zonal structure of the corpus of *Oryza* described in terms of the cyto-histological properties of its component cells is similar

to that of *Sinocalamus* (Hsu, 1944), *Agropyron* (Sharman, 1945), and to the corpus of the shoot apex considered by Popham (1951) as common in flowering plants. The corpus of this rice variety consists of three distinct zones. Zone 1 occupies the central portion of the apical meristem immediately below the tunica layers at the summit. Its cells divide in all planes and give rise centrally to zone 3 and peripherally to zone 2. Sharman (1945) calls this zone "initial group of cells"; Hsu (1944), Stant (1952, 1954), and Ledin (1954), "Corpus initial zone"; Popham (1951), "sub-apical initial zone".

Zone 3 lies below zone 1 and gives rise to the pith by transverse divisions of its cells. Sharman (1945) calls this zone "apical pith", while Hsu (1944) and Stant (1952, 1954) refer to it as "rib meristem". Popham (1951) calls this zone "central meristem".

Zone 2 surrounds zone 3. The cells of this zone were associated with the formation of lateral buds. Sharman (1942, 1945) calls it "sub-hypodermal layer"; Stant (1952, 1954) and Ledin (1954), "flank meristem"; Hsu (1944) and Popham (1951), "peripheral meristem". The adoption of standard terminology, though perhaps unimportant in itself, is probably of value in minimizing confusion and misconceptions among workers in labeling the zones of cells in the corpus.

An apical initial cell for the tunica is reported to be frequently present in the apical meristem of *Triticum* (Rosler, 1928) and *Avena* (Kliem, 1937). No such cell has been observed in either of the two tunica layers in *Oryza*. All the cells at the summit of the apex appear more or less uniform in shape and possibly in cellular activity. The situation (in *Oryza*) has also been found in *Sinocalamus* (*Hsu*, 1944), in *Agropyron* (Sharman, 1951) and in *Zea* (Ledin, 1954).

Rosler (1928) and Kliem (1937) also observed a single prominent initial cell in the corpus of *Triticum* and *Avena*, respectively, which produces segments in a manner comparable to a typical apical initial cell of other vascular plants. The zone of corpus initials (zone 1) in *Oryza*, as observed in this investigation is composed of several cells which are more or less uniform in size and shape. In some instances, however, a large and usually centrally located cell was observed in this zone. Nevertheless, adjacent sections frequently show similar large cells which are not always centrally located; such cells even appear in the tunica layers down the flanks

of the apical dome. The appearance of these cells probably results from sections median to their greatest diameters.

LITERATURE CITED

BALL, E. 1941. Microtechnique for the shoot apex. Amer. Jour. Bot. **28**: 233-243.

BOKE, N. H. 1939. Delafield's hematoxylin and safranin for staining meristematic tissues. Stain Tech. **14**: 129-131.

BROWN, V. W., C. HEIMSCH, and W. H. P. EMERY. 1957. The organization of the grass shoot apex and systematics. Amer. Jour. Bot. **44**: 590-595.

CROSS, G. L. 1936. An improved method of staining with fast green. Proc. Oklahoma Acad. Sci. **17**: 69-70.

———— and T. J. JOHNSON. 1941. Structural features of the shoot apices of diploid and colchicine-induced tetraploid stains of *Vinca rosea* L. Torrey Bot. Club Bul. **68**: 618-635.

CUTTER, E. G. 1955. Anatomical studies on the shoot apices of some parasitic and saprophytic angiosperms. Phytomorph. **2-3**: 231-247.

DOULIOT, H. 1891. Recherches sur la croissance terminal de la tige et de la feuille chez les Graminees. Ann. Sci. Nat. Bot. 13, ser. **7**: 93-102.

FOSTER, A. S. 1934. The use of tannic acid and iron chloride for staining cell walls in meristematic tissue. Stain Tech. **9**: 91-92.

GIFFORD, E. M. 1950. The structure and development of the shoot apex in certain woody Ranales. Amer. Jour. Bot. **37**: 595-611.

HSU, J. 1944. Structure and growth of the shoot apex of *Sinocalamus Beecheyena* McClure. Amer. Jour. Bot. **31**: 404-411.

JOHANSEN, D. A. 1940. Plant Microtechnique. New York: McGraw-Hill Book Co. xi + 523 pp.

KLIEM, F. 1937. Vegetationspunkt un Blattanlage bei *Avena sativa*. Beitrage Biol. Pflansen. **24**: 281-310.

LEDIN, R. B. 1954. The vegetative shoot apex of *Zea mays*. Amer. Jour. Bot. **41**: 11-17.

POPHAM, R. A. 1951. Principal types of vegetative shoot apex in vascular plants. Ohio Jour. Sci. **51**: 249-270.

REEVE, R. M. 1942. Structure and growth of the vegetative shoot apex of *Garrya elliptica* Dougl. Amer. Jour. Bot. **29**: 687-711.

———— 1948. The "tunica-corpus" concept and development of shoot apices in certain dicotyledons. Amer Jour. Bot. **35**: 65-75.

ROUFFA, A. S. and J. E. GUNCKEL. 1951. Leaf initiation, origin and pattern of pith development in the Rosaceae. Amer. Jour. Bot. **38**: 301-307.

ROSLER, P. 1928. Histologische Studien am Vegetations-punkt von *Triticum vulgare*. Planta **5**: 28-69.

SHARMAN, B. C. 1940. A periclinal division in the "dermatogen" at the tip of the maize growing point. Nature **146**: 778.

———— 1942. Developmental anatomy of the shoot of *Zea mays* L. Ann. Bot. **6**: 245-282.

———— 1943a. A periclinal division in the "demartogen" at the tip of the growing point of couch grass, *Agropyron* repens Beaux. Nature **152**: 176.

———— 1943b. Tannic acid and iron alum with safranin and orange G in slides of the shoot apex. Stain Tech. **18**: 105-111.

———— 1945. Leaf and bud initiation in the Gramineae. Bot. Gaz. **106**: 269-289.

SCHMIDT, A. 1924. Histologische Studien an Phanerogamen Vegetationspunkten. Bot. Arch. **8**: 345-404.

SCHNABEL, V. 1941. Der Bau der Sprossvegetationspunkte von *Honckenya peploides, Silene maritima, Dianthus caryophyllus und Clematis paniculata.* Bot. Arch. **42**: 461-502.

STANT, M. Y. 1952. The shoot apex of some monocotyledons. I. Structure and development. Ann. Bot. N. S. **16**: 115-128.

———— 1954. The shoot apex of some monocotyledons. II. Growth organization. Ann. Bot. N. S. **18**: 441-447.

STERLING, C. 1944. On the shoot apex of *Chlorogalum pomeridianum* (DC.) Kunth. Madrono **7**: 188-192.

SUSSEX, I. M. 1955. Morphogenesis in *Solanum tuberosum* L.: Apical structure and developmental pattern of the juvenile shoot. Phytomorph. **2-3**: 253-273.

THIELKE, C. 1951. Uber die Moglichkeiten der Periklinal-chimarenbildung bei Grasern. Planta **39**: 402-430.

ZIMMERMANN, W. A. 1928. Histologische Studien am Vegetationspunkt von *Hypericum uralum.* Jahrb. f. Wiss. Bot. **68**: 289-344.

EFFECT OF SPACING UPON THE YIELD OF TICK CLOVER [*Desmodium intortum* (Mill.) Urb.] [1]

V. C. Calma, F. O. Valera and F. I. Santos

Four spacings (20, 40, 60 and 80 cm.) between hills on furrows set 90 centimeters apart (experiment 1), and 20-centimeter hill spacing in furrows set 25, 50, 75, and 100 centimeters apart (experiment 2) were studied.

Tick Clover grown at 20 centimeters between hills and 90 centimeters between furrows gave the highest yield of fresh and air-dried forage (experiment 1). The percentages of germination and of stand of plants, flowering habits, and proximate chemical analysis of forage were not definitely influenced by spacing. The closest spacing (20 × 25 cm.) gave the highest yield of both fresh and air-dried forage, while the widest spacing (20 × 100 cm.) yielded lowest (experiment 2). The fresh and air-dried yields invariably increased with more number of plants per unit area. Adequate management practices and closer spacings may further increase the yield of this forage.

Tick Clover is one of the most important and widely grown leguminous forage crops in Central America. Seeds of this legume procured from Guatemala were introduced in the U.P. College of Agriculture through Mr. Hepler of the ICA (International Cooperation Administration) in August, 1951. In Guatemala, Tick Clover is commonly used as pasture for hogs. It is also cured into hay and then ground and mixed with the ration like alfalfa.

Because Tick Clover is relished by practically all kinds of livestock and thus has a great possibility as a forage in the Philippines, this study was conducted in the experimental field and in the laboratory room of the Farm Crops Division, Department of Agronomy, from June 27, 1955, to December 12, 1957. Its primary objectives were to compare fresh and air-dried yields of Tick Clover planted at various spacings and to study its important agronomic characters.

MATERIALS AND METHODS

Experiment 1

On June 27, 1955, a 360-square-meter field of clay loam soil was plowed and harrowed twice alternately. It was divided into five

[1] Central Experiment Station Contribution No. 2001.

blocks, each consisting of four 18-square-meter plots. Two furrows were set 90 centimeters apart in each plot. The treatments were numbered and assigned at random to the different plots.

On July 2, 1955, 30-centimeter vine cuttings of Tick Clover were prepared. One cutting was planted to each hill. In treatment I the hills were set 20 centimeters apart; treatment II, 40 cm.; treatment III, 60 cm.; and treatment IV, 80 cm.

Two weeks after planting, the missing hills were replanted with living plants from the guard rows. The field was hand-weeded as often as necessary. One week thereafter, the plants were hilled-up. One week after each cutting, the plants were off-barred and then hilled-up seven days later. Hilling-up was the final cultivation made between harvests. Incidence of pests and diseases was observed.

The percentage of germination and of stand were determined two weeks after planting and every time the crop was harvested. The flowering habits of the plants were closely observed.

Harvesting was done when majority of the vines were about 40 to 50 centimeters long. The plants were scythed about 10 centimeters above the ground. The first crop was harvested on August 31, 1955, 60 days after planting; the second on October 29, 1955, 59 days after; the third, on January 23, 1956, 86 days after; and the fourth, on May 14, 1956, 101 days after. Continuous heavy rain for two weeks delayed the third harvest so that the pods almost reached maturity at harvest time. The fresh forage was weighed immediately after harvest.

A 200-gram sample was taken at random from every plot immediately after weighing. All of the 200-gram samples from five replications except in the fourth harvest where only four replications were considered, were mixed to represent a one-kilogram composite sample of each treatment. The samples were brought to the Department of Agricultural Chemistry for proximate chemical analysis.

The rest was brought to the laboratory room of the Department of Agronomy and scattered separately for air-drying. The air-dried weights from each harvest were taken three to four times until constant weights were obtained. The air-dried weight of the sample analyzed from each plot was computed and added to the air-

dried weight of the remaining harvest to get the total air-dried weight of the harvest for each plot.

Experiment 2

A 404-square-meter field was plowed and harrowed twice alternately. The area was divided into four replications, consisting of four plots each, and with 18 square meters to a plot. Distances between furrows were as follows: treatment I, 25 cm.; treatment II, 50 cm.; treatment III, 75 cm.; and treatment IV, 100 cm.

On July 24, 1956, vine cuttings of Tick Clover, each 30 centimeters long, were prepared. One cutting was planted 20 centimeters apart in the furrow. This was the best distance of planting found in experiment 1. Three weeks after, missing hills were replanted with those from border rows. Plants were weeded and cultivated whenever necessary. The presence of pests and diseases was closely observed.

The percentage of germination and stand of plants were noted two weeks after planting and after every harvest. Flower emergence of plants in the different treatments was also observed.

Harvesting was performed when majority of the vines were approximately 50 centimeters long. The plants were scythed about ten centimeters from the ground. First harvesting was done on October 2, 1956, 58 days from planting; the second, on December 16, 1956, 72 days after; the third, on May 15, 1957, 149 days after; and the fourth, on August 5, 1957, 80 days after.

The dry weather early in December, 1956, apparently retarded the growth of plants, thereby delaying the third harvest. Weight of fresh forage from different treatments was determined immediately after every harvest to minimize loss of moisture. The forage was air-dried separately in the shed house. The air-dried weight of each harvest was taken three to four times until constant weights were obtained.

RESULTS AND DISCUSSION

Experiment 1 [2]

Percentage of germination and stand of the plants. Data on the results of experiment 1 are given in the summary table.

[2] The first three harvests in experiment 1 were made by Mr. Albaro B. Silva who conducted his thesis under the supervision of the senior author.

The cuttings in all the treatments sprouted about seven days after planting. It took only four to five days for the plants in all the treatments to sprout after the first, second, and third harvests. The differences in the percentage of germination taken two weeks after planting between treatments were not significant.

The stand of the plants during the first harvest was uniform in all treatments, probably because all the missing hills were replanted with living plants taken from the border rows two weeks after planting, and favorable rainfall followed after replanting. All of the spacing treatments showed no significant effects on the percentage of stand of the plants in the first, second, and third harvests.

Pests and diseases. No serious pest or disease attacked the plants during the experiment.

Flowering habits of the plants. The plants did not flower at the early part of the experiment. This was due to the seasonal flowering characteristic of the plants. The plants flowered in the early part of December, 1955, almost at the same time, indicating that flowering was not influenced by the distance of planting.

Comparative yields of fresh forage. The variations in yield of fresh forage between treatments were highly significant. Treatment I gave the highest mean yield of fresh forage, (12.67 kg.). The yields of fresh forage in tons to a hectare were as follows: for treatment I, 7.039; treatment II, 5.949; treatment III, 4.155; and treatment IV, 3.422.

Treatment I had the highest mean yield of fresh forage in the third harvest. The yields of fresh forage in tons to a hectare in the third harvest were as follows: for treatment I, 4.530; treatment II, 3.199; treatment III, 3.377; and treatment IV, 3.420.

The differences in yield of fresh forage in the fourth harvest between treatment I and any other treatment were highly significant. The yields of fresh forage in tons to a hectare were 4.505, 3.588, 3.261, and 3.199 for treatments I, II, III, and IV, respectively.

The total yields of fresh forage in tons to a hectare of the four harvests were as follows: for treatment I, 41.62; treatment II, 32.15; treatment III, 28.75; and treatment IV, 20.04.

The yield of fresh forage in the second harvest was the highest, followed by the first harvest; that of the fourth harvest was the

lowest. These differences in yield were due to the better-developed root systems of the plants during the second harvest compared with those of the first harvest which had just recovered from the adverse effects of planting. Besides, the plants during the third harvest which flowered in December were still short and did not increase in length until they were harvested. Poor yield in the fourth harvest was attributed to insufficient moisture in the field during the latter part of summer when the plants were harvested.

Comparative yields of air-dried forage. Spacing treatments gave significant variations in the yields of air-dried forage. Treatment I gave 11.48 kilograms of air-dried forage, which was significantly higher than treatment II, with 9.84 kilograms, treatment III, 6.94 kilograms, and treatment IV, 5.56 kilograms. Treatment II, however, gave approximately the same yield as treatment IV. The yields of air-dried forage in the first harvest were as follows: treatment I, 1.276 tons per hectare; treatment II, 1.099; treatment III, 0.771; and treatment IV, 0.617.

Treatment I gave the highest significant yield of air-dried forage per plot in the second harvest. However, there were no significant differences in yield among the other treatments. The yields of air-dried forage in tons to a hectare were as follows: for treatment I, 1.755; treatment II, 1.244; treatment III, 1.133; and treatment IV, 1.155.

Treatment I gave the highest yield of air-dried forage in the third harvest. The yields of air-dried forage in tons to a hectare were as follows: treatment I, 1.633; treatment II, 1.188; treatment III, 1.240; and treatment IV, 1.322.

Treatment I gave the highest mean yield of air-dried forage in the fourth harvest. The yields of air-dried forage in tons to a hectare were as follows: treatment I, 1.211; treatment II, 0.905; treatment III, 7.14; and treatment IV, 6.82.

As a whole, the results showed that only treatment I (20 x 90 cm.) consistently and significantly gave the highest yields in both the fresh and air-dried weights of forage in all the four harvests. The rest of the treatments did not vary in fresh and air-dried yields of forage except in the first harvest where treatment II (40 x 90 cm.) gave higher yields of fresh and air-dried forage than in either treatment III or IV.

Average proximate chemical analysis. The treatments had no influence on the proximate chemical analysis of the forage. The differences between the different harvests in the proximate chemical analysis were due probably to differences in climatic conditions and to different stages of growth at harvest. The percentage of nitrogen-free extract and of crude fibers in the third harvest was higher than in the first or second harvest, probably because the third harvest was made when the pods were almost mature.

Summary table

CHARACTER MEASURED	TREATMENT MEANS				SIGNIFICANT DIFFERENCE	
	I	II	III	IV	.05	.01
Germination percentage						
Two weeks after planting	87.8	91.6	97.0	89.4	Not significant	
After the 1st harvesting	93.0	88.4	88.0	89.6	"	"
After the 2nd harvesting	92.4	87.4	86.6	83.8	"	"
After the 3rd harvesting	89.7	85.2	85.2	81.5	"	"
Fresh-forage yield (kg./plot)						
First harvest	12.67	10.71	7.48	6.16	3.90	5.34
Second harvest	12.68	9.72	9.36	8.92	1.91	2.58
Third harvest	8.16	5.76	6.08	6.20	2.56	3.45
Fourth harvest	8.11	6.46	5.87	5.76	1.65	2.23
Air-dried forage (kg./plot)						
First harvest	2.296	1.968	1.388	1.112	0.729	0.983
Second harvest	3.160	2.240	2.040	2.080	1.140	—
Third harvest	2.940	2.140	2.240	2.380	0.663	—
Fourth harvest	2.180	1.630	1.480	1.250	Not significant	

YIELD (tons/ha.)

SPACING	1ST HARVEST (Aug. 31/55)	2ND HARVEST (Oct. 29/55)	3RD HARVEST (Jan. 23/56)	4TH HARVEST (May 14/56)	TOTAL
I (20 × 90 cm.)					
Fresh	7.039	7.044	4.530	4.505	23.118
Dry	1.276	1.755	1.633	1.211	5.875
II (40 × 90 cm.)					
Fresh	5.949	5.399	3.199	3.588	18.135
Dry	1.093	1.244	1.188	0.905	4.430
III (60 × 90 cm.)					
Fresh	4.155	5.177	3.377	3.261	15.970
Dry	0.771	1.133	1.240	0.788	3.932
IV (80 × 90 cm.)					
Fresh	3.422	4.955	3.420	3.199	15.016
Dry	0.617	1.155	1.322	0.694	3.788

Experiment 2

Percentage of germination and stand of the plants. Data on the results of experiment 2 are given in the summary table. There was a uniform germination of plants in all treatments. Complete germination was observed seven days after planting. It took four to six days for the buds to sprout after the first and second harvests and six to nine days after the third harvest. There was practically no rain before and after the third harvest so that moisture was pointed out as the limiting factor in the rejuvenation of the plants.

The percentage of germination of plants two weeks after planting and after the first harvest was almost 100 per cent. In the succeeding harvests, although the number of dead hills was slightly higher in the wider spacing, the differences in percentage germination between treatments were not significant.

Pests and diseases. There was no pest or disease found attacking the plants during the experiment.

Flowering habits of the plants. As in experiment 1 the plants flowered only in the early part of December. No sign of flowering was observed in the early and later parts of the experiment.

Comparative yields of fresh forage. The yield of fresh forage was significantly influenced by the different spacings. Treatment I gave the highest mean yield of fresh forage in kilograms to a plot followed in descending order by treatments II, III, and IV. The yields of fresh forage in tons to a hectare in the first harvest were as follows: treatment I, 7.91; treatment II, 6.90; treatment III, 6.24; and treatment IV, 5.09.

The differences in yields in the second harvest were highly significant. The yields in tons to a hectare were as follows: treatment I, 8.41; treatment II, 7.77; treatment III, 6.77; and treatment IV, 5.56.

Treatment I gave the highest mean yield of fresh forage in the third harvest. The yields of fresh forage in tons to a hectare were 7.19, 6.66, 5.66 and 4.61 for treatments I, II, III, and IV, respectively.

The differences in yield of fresh forage in kilograms per plot in the fourth harvest were significant at five per cent level. The yields in tons to a hectare were as follows: treatment I, 7.21; treatment II, 6.62; treatment III, 5.38; and treatment IV, 4.25.

The total yields of fresh forage from four harvests were as follows: treatment I, 30.73 tons to a hectare; treatment II, 27.96; treatment III, 24.07; and treatment IV, 19.60.

The four succeeding harvests showed that spacing between rows has a marked influence on the yield of fresh forage. Treatment I (20 x 25 cm.) gave consistently higher yields than the other treatments. There seems to be a possibility that higher yields will be obtained with closer spacings.

Comparative yields of air-dried forage. The yield of air-dried forage gave highly significant variations between treatments. Treatment I gave the highest mean yield of air-dried forage in kilograms per plot in the first harvest. The yields of air-dried forage in tons per hectare were as follows: treatment I, 1.755; treatment II, 1.588; treatment III, 1.199; and treatment IV, 0.916.

In the second harvest, the differences between treatment I and treatment III or IV, however, were highly significant. Treatment I gave a higher mean yield than treatment II, but they did not differ statistically. The yields in tons per hectare were as follows: treatment I, 2.138; treatment II, 1.866; treatment III, 1.305; and treatment IV, 1.138.

Treatment I gave the highest mean yield of air-dried forage. It yielded significantly higher than any of the other treatments. The yields in tons per hectare were as follows: treatment I, 1.483; treatment II, 0.933; and treatment IV, 0.538.

Treatment I gave the highest mean yield of air-dried forage in the fourth harvest. The differences among treatments were highly significant. The yields in tons to a hectare were as follows: treatment I, 1.555; treatment II, 0.955; treatment III, 0.722; and treatment IV, 0.466.

Treatment I (20 x 25 cm.) consistently gave the highest mean yield of air-dried forage, followed in descending order by treatments II, III, and IV. The second harvest gave the highest amount of forage followed by the first, third, and fourth harvests.

The increase in yield of the first over the second harvest was due to the production of fully established root systems and the stimulation of more shoots by the first harvest. The gradual decrease in yield thereafter, may be attributed to the increasing number of dead hills and to the depletion of root reserves.

Summary table

CHARACTER MEASURED	TREATMENT MEANS				SIGNIFICANT DIFFERENCE	
	I	II	III	IV	.05	.01
Germination percentage						
Two weeks after planting	99.50	97.75	98.25	98.50	Not significant	
After the 1st harvesting	100.00	99.50	99.50	99.00	"	"
After the 2nd harvesting	97.50	96.50	97.00	95.25	"	"
After the 3rd harvesting	87.50	86.25	88.00	86.26	"	"
Fresh-forage yield (kg./plot)						
First harvest	14.24	12.42	11.25	9.17	0.79	1.07
Second harvest	15.15	14.00	12.20	10.18	1.94	1.62
Third harvest	12.95	12.00	10.20	8.30	0.66	0.89
Fourth harvest	12.98	11.92	9.70	7.65	0.75	1.01
Air-dried weight (kg./plot)						
First harvest	3.16	2.86	2.16	1.65	0.48	0.65
Second harvest	3.85	3.36	2.35	2.05	0.39	0.53
Third harvest	2.67	1.68	1.51	0.97	0.45	0.61
Fourth harvest	2.80	1.72	1.30	0.84	0.31	0.41

YIELD (tons/ha.)

SPACING	1ST HARVEST (Oct. 2/56)	2ND HARVEST (Dec. 16/56)	3RD HARVEST (May 15/57)	4TH HARVEST (Aug. 5/57)	TOTAL
I (20 × 25 cm.)					
Fresh	7.910	8.416	7.194	7.211	30.731
Dry	1.755	2.138	1.483	1.555	6.931
II (20 × 50 cm.)					
Fresh	6.899	7.777	6.666	6.622	27.964
Dry	1.588	1.866	0.933	0.955	5.342
III (20 × 75 cm.)					
Fresh	6.255	6.777	5.660	5.388	24.075
Dry	1.199	1.305	0.838	0.722	4.064
IV (20 × 100 cm.)					
Fresh	5.094	5.655	4.611	4.249	19.609
Dry	0.916	1.138	0.538	0.466	3.058

SUMMARY AND RECOMMENDATION

1. The distance of planting Tick Clover did not have any significant effect upon germination, percentage of stand, and flowering.

2. In the production of fresh and air-dried forage, the best distance of planting was 20 centimeters between hills and 25 centimeters between furrows.

3. The different spacing treatments had no definite influence on the proximate chemical analysis of the forage. However, there were slight variations in chemical analysis of the different treatments. This was probably due to differences in climatic conditions and age of the plants at harvest time.

4. Since the closest spacing used, 20 x 25 cm., gave the highest yield of forage, much closer spacings should be tried in a future study.

"INERT" DUSTS FOR THE CONTROL OF STORAGE INSECTS OF SHELLED CORN[1]

G. B. VIADO and R. M. LABADAN

Of the three "inert" dusts tested at the rate of five and 10 grams per kilogram of shelled corn for the control of stored grain insects, Maquiling clay or "white earth" was more effective than rice hull ash and sugar cane bagasse ash. The rice hull ash was more effective than the sugar cane bagasse ash. The fineness and high sticking quality of "white earth" dust may explain why it was more effective than the other two dusts against storage insects of shelled corn.

The rice weevil, *Sitophilus oryza* (L.) and the lesser grain borer, *Rhizopertha dominica* (Fabr.). were the most numerous and the most destructive of the nine species of insects found in the sacks.

Toxic residues on food products treated with pesticides for the control of insect pests hinder the efficient and extensive use of these chemicals on stored grains. Insecticides of low mammalian toxicity which are either ineffective against these insect pests or have very short residual toxicity are unsuited for the purpose.

Some authors (Chiu, 1939a and 1939b; Fitzgerald, 1944; Jurado, 1942; Lopez, 1942; Iyengar, 1945; and Grandori, 1952) reported the effectiveness of "inert" materials against several stored product insects; others (Chiu, 1939a; Griscoe, 1943; Alexander *et al.*, 1944; Fitzgerald, 1944; Nagasawa, 1947; and Yasue, 1947) claimed varying effectiveness of inert dusts under different conditions of temperature, humidity, and size of particles. Cotton *et al.* (1942) found that inert dusts such as ground quartz sand, activated pyrophyllite, wood ash, lime sulfur and soybean flour gave inadequate protection to stored grain from insect attack. Ground paddy husk ash was reported by Krisnamurty (1946) and Rao (1951) as effective in controlling stored grain insects.

Chiu (1939a and 1939b), Alexander *et al.* (1944) and Nagasawa (1947) reported that inert dusts killed insects by desiccation, while other investigators found that these materials killed in other ways. Lopez (1942) found that the mouth parts of larvae of Coleop-

[1] Central Experiment Station Contribution No. 2002. Part of Research Project No. 909 financed by a grant from the NARIC (National Rice and Corn Corporation).

tera and Lepidoptera infesting treated stored grain were clogged with the dust and the larvae died mainly of hunger. Briscoe (1943) reported that the dusts did not penetrate the respiratory system but some entered the digestive tract, preventing feeding by the insects. Uchida (1947) found that kaolin and acid clay apparently killed bean weevil mainly by impairment of the digestive system and loss of water in cleaning its body from the dust.

Alexander *et al.* (1944) found that the physical rather than the chemical nature of inert dusts increased the rate of evaporation of water from these insects and the finer the dust particles the more effective they were. They theorized that the dusts increased the water loss from insects by disrupting the water-resistance of the epicuticle and that different insects differed in their protective coating of this material and that perhaps some insects were able to renew it more rapidly than others. They also found that the effectiveness of the dust was confined almost entirely to increasing evaporation of water and that harmful effects from ingestion of the dust were negligible.

Dust prepared from "white earth", a clay found in Mt. Maquiling, may also prove effective against insects infesting stored shelled corn. To determine the efficacy of this material and those of finely ground sugar-cane bagasse ash and rice hull ash, this study was conducted from December, 1956, to December, 1957, at the laboratory of the Department of Entomology, U.P. College of Agriculture and Central Experiment Station.

MATERIALS AND METHODS

Maquiling clay or "white earth" dust was prepared by wet grinding.[2] The sugar-cane bagasse ash and the rice hull ash were ground and passed through a 200-mesh sieve. Hand-shelled, non-infested and thoroughly dried yellow flint corn was used.

Two concentrations of the dust were used, 0.5 and 1.0 per cent of the weight of the grain, or five and 10 grams of the dust per kilogram of grain. To insure a more or less even coating of the grain with the dust, one kilogram of grain was mixed at a time. The grain with the measured dust was placed in a glass jar with a tight-fitting lid, shaken thoroughly and emptied into gunny and cotton sacks. Each sack contained five kilograms of the treated grain.

[2] The process by which the clay is ground wet, the suspended material allowed to settle, the liquid decanted and the precipitate dried and ground.

The treatments were replicated five times. The tagged sacks were distributed at random on open shelves in the heavily infested storage room, taking care that the bags did not touch each other.

The temperature of the room for the duration of the test ranged from 23.9° C to 35.0°C.

Counts on damaged kernels, adult insect population and weight of the grain were taken every three months. Each bag was opened, the contents poured into a pan, mixed thoroughly and 500 kernels taken at random to examine insect injury. The percentage of damaged kernels, number of adult insects within the sack and weight of the entire contents were also taken.

RESULTS AND DISCUSSION

The stored grain insects found in the infested room at the time of the test and arranged in the descending order of their abundance are as follows:

Rice weevil, *Sitophilus oryza* (L.)
Lesser grain borer, *Rhizopertha dominica* (F.)
Rice moth, *Corcyra cephalonica* (Staint.)
Saw-toothed beetle, *Oryzaephilus surinamensis* (L.)
Rust-red flour beetle, *Tribolium castaneum* (Herbst.)
Cacao moth, *Ephestia elutella* (Hbn.)
Flat grain beetle, *Laemophloeus pusillus* (Schonh.)
Cadelle, *Tenebroides mauritanicus* (L.)
Cigarette beetle, *Lasioderma serricorne* (F.)
Coffee bean weevil, *Araecerus fasciculatus* (Deg.)
A species of unidentified beetle [3]
Corn sap beetle, *Carpophilus dimidiatus* (F.)
Angoumois grain moth, *Sitotroga cerealella* (Oliv.)
A species of unidentified moth [3]
Indian meal moth, *Plodia interpunctella* (Hbn.)

S. oryza and *R. dominica* were the most abundant. The other species were few and did not increase as fast as the two species throughout the test.

Effect on insect population in the sacks. The rice weevil, *S. oryza*, was the most numerous species found in the sacks. The mean

[3] Specimens sent to the U. S. National Museum, Washington, D. C., for identification.

number of adult weevils in the two kinds of containers after a specified number of months are shown in table 1.

TABLE 1.—*Mean number of adult Sitophilus oryza per sack after specified number of months*

TREATMENT	COTTON				GUNNY			
	Months				Months			
	3	6	9	12	3	6	9	12
White earth, 5 gm.	0	3.2	7.2	3.4	384.4	24.0	55.6	108.0
White earth, 10 gm.	0	4.4	5.2	3.6	228.8	22.4	26.2	57.0
Sugar-cane bagasse ash, 5 gm.	15.8	6.6	5.4	6.4	253.0	134.4	161.8	919.0
Sugar-cane bagasse ash, 10 gm.	6.4	5.0	4.8	2.6	278.6	124.6	242.6	1489.6
Rice hull ash, 5 gm.	3.4	2.4	7.2	5.4	382.4	133.4	225.8	346.6
Rice hull ash, 10 gm.	3.0	4.0	5.6	4.2	322.6	133.8	210.6	534.6
Control	5.4	7.0	7.0	12.8	1100.2	162.8	513.4	1437.4
H.S.D. (T) 5%	[a]	[a]	[a]	[a]	845.34	33.14	69.46	703.70
1%					[a]	40.44	84.76	858.70

[a] Not significant.

The total number of living and dead adults in the container were counted. In the cotton sacks, the highest number in the control was recorded 12 months from the start of the test while the highest number in the bags treated with five grams sugar-cane bagasse ash was recorded after three months. No adult weevils were found in the lots treated with five and 10 grams of white earth three months from the start of the experiment. It was observed that this dust had a very high sticking quality to the grain compared with the other dusts. This may explain the difference in effectiveness of this material compared with the other dusts. All the treatments in the cotton sack containers did not reduce significantly the number of adult weevils present. This may be attributed to the closeness of weave of the sack rather than to the treatments. It is likely that the insects entered through the seams of the sacks.

Adult population of *S. oryza* in the gunny sacks was comparatively much higher than that in the cotton sacks. Evidently the coarseness of weave of the gunny sack caused the difference in population, the adult weevils being able to get into the sack readily. The highest number of adult beetles during the four periods of observation was recorded in the untreated or control bags, except at 12 months when the number in the grains treated with 10 grams bagasse ash was

slightly higher than that in the control. The lowest number in the four observations was in the lot treated with 10 grams of "white earth". There was a significant difference among the treatments at one per cent level of probability from six months after treatment to the end of the test. "White earth" at five and 10 grams was significantly better than sugar-cane bagasse ash and rice hull ash at both rates of application. All the treatments in the gunny sacks significantly reduced the number of insects except at three months when significance was recorded only at the five per cent level of probability.

Next to *S. oryza* in abundance was the lesser grain borer, *R. dominica*. Adult counts in the two kinds of containers during the four periods of observation showed significant difference between the control and treated except at 12 months in the cotton container in which the difference was not significant (table 2). In the cotton

TABLE 2.—*Mean number of adult Rhizophertha dominica per sack after specified number of months*

TREATMENT	COTTON				GUNNY			
	Months				Months			
	3	6	9	12	3	6	9	12
White earth, 5 gm.	0	0	0.4	0	95.4	67.8	34.2	24.8
White earth. 10 gm.	0	0.4	0.2	0	126.2	36.6	6.2	5.6
Sugar-cane bagasse ash, 5 gm.	17.4	40.0	7.6	11.6	11.2	272.6	516.4	844.0
Sugar-cane bagasse ash, 10 gm.	21.0	57.8	11.0	7.6	32.0	266.4	515.0	969.0
Rice hull ash, 5 gm.	8.6	8.4	5.6	1.2	16.8	276.8	325.6	207.0
Rice hull ash, 10 gm.	19.8	61.2	24.0	7.6	14.2	257.2	1114.0	974.8
Control	27.8	22.0	48.4	26.6	27.8	62.0	424.2	491.4
H.S.D. (T) 5%	19.52	54.03	38.59	[a]	44.49	102.15	202.48	759.08
1%	23.82	[a]	47.09		54.29	124.65	247.08	926.29

[a] Not significant.

container, no adult *R. dominica* was found three months from the start of the test in the grain treated with "white earth". The mean number per sack found at six and nine months was less than one adult, indicating almost complete protection afforded by "white earth" from this insect. The other dusts failed to protect the grain from the beetle.

In the gunny sack, the mean differences between treatments and the control were significant at both the five and one per cent

levels. Except for the "white earth", there was an increase in the number of adults from the first to the last observation in the other treatments and the control. There was, however, a drop at 12 months in the rice hull ash treatment. It is interesting to note that population was much higher in the "white earth" than in the other treatments including the control at three months, but there was a consistent decrease from then on to the end of the test. Although the number of beetles was high in the first observation, it was apparent that they were not able to breed inside the sacks containing the grain treated with "white earth".

Observations on other species showed a peak in population at six months for *L. serricorne, T. mauritanicus* and *A. fasciculatus* and at nine months for *O. surinamensis, T. castaneum,* and *L. pusillus* in all the treatments. As found in the other two species, the best control for all these six species was the "white earth", followed by rice hull ash and sugar-cane bagasse ash.

Effects on insect damage to the grains. Table 3 shows mean percentages of damaged kernels in the cotton sacks. The infestation in this container was much lighter compared with that in the

TABLE 3.—*Mean percentages of damaged kernels in cotton and gunny sacks after specified number of months*

TREATMENT	MONTHS							
	3		6		9		12	
	Actual	Angle	Actual	Angle	Actual	Angle	Actual	Angle
White earth, 5 gm.	0	0	0.76	4.43	0.76	4.43	0.80	4.93
White earth, 10 gm.	0	0	0.40	3.15	1.08	5.90	1.40	6.28
Sugar-cane bagasse ash, 5 gm.	1.72	7.10	2.00	7.63	2.36	8.40	2.52	9.10
Sugar-cane bagasse ash, 10 gm.	0.11	5.95	1.84	7.67	1.96	8.04	2.76	9.36
Rice hull ash, 5 gm.	1.60	7.08	1.84	7.67	1.88	6.98	2.04	7.90
Rice hull ash, 10 gm.	1.64	7.24	1.68	7.36	1.72	7.08	2.00	7.63
Control	2.88	9.06	4.60	11.97	6.08	13.13	6.16	13.18
H.S.D. (T) 5%		3.63		4.08		6.35		6.35
1%		4.43		4.98		7.75		7.75

gunny sack. In all the treatments including the control there was a consistent, though very small increase in the mean percentages of damaged kernels from the start to the end of the test. At the end of 12 months only about one per cent of the grains in the lot treated

with "white earth" was damaged, about 2.0 in the rice hull ash, about 2.6 in the sugar-cane bagasse ash, and 6.16 in the control or untreated grains. Increasing the amount of the dust apparently did not reduce infestation. The differences between the treatments and the control were significant in the four observations. The "white earth" at both levels of concentration was significantly better than either the rice hull ash or the sugar-cane bagasse ash. The most effective treatment in this lot was "white earth", followed by rice hull ash and sugar-cane bagasse ash.

The mean percentages of damaged kernels in the gunny sacks were much higher than those in the cotton sacks (table 4). As in the cotton sack containers, there was a consistent increase in the percentages of damaged kernels throughout the test. The difference between the means in the control and the treatments was significant in the four observations. The best of the three dusts at the end of 12 months was "white earth" which gave only 13.0 per cent damaged kernels against 81.8 per cent in the control. The next best was rice hull ash and the least effective was sugar-cane bagasse ash.

TABLE 4.—*Mean percentages of damaged kernels in gunny sacks after specified number of months*

TREATMENT	MONTHS							
	3		6		9		12	
	Actual	Angle	Actual	Angle	Actual	Angle	Actual	Angle
White earth, 5 gm.	6.68	14.97	8.92	17.34	10.20	18.60	13.00	21.09
White earth, 10 gm.	10.28	18.43	11.80	19.99	13.92	21.72	14.88	22.21
Sugar-cane bagasse ash, 5 gm.	47.16	43.31	60.88	51.50	63.40	52.91	85.52	68.37
Sugar-cane bagasse ash, 10 gm.	33.36	35.09	41.08	39.74	57.84	49.81	81.80	66.09
Rice hull ash, 5 gm.	40.24	39.21	47.84	44.21	48.56	44.20	58.56	50.56
Rice hull ash, 10 gm.	61.84	52.13	65.76	54.46	73.24	59.80	79.68	63.89
Control	83.60	67.03	90.44	73.02	93.96	76.26	97.52	81.75
H.S.D (T) 5%		12.71		13.06		16.34		15.79
1%		15.51		17.17		19.94		20.49

The results showed that while all the three materials tested significantly reduced infestation by stored product insects, the "white earth" or koalin was superior to sugar-cane bagasse ash and rice hull ash.

Effects on the weight of the grains. Table 5 shows the differences in the mean per cent loss of weight of the grains in the cotton and gunny sacks in the different treatments at various periods of observations. In the cotton sacks, the difference between the treatments and the control was insignificant. There was only a slight loss in weight from the start of the experiment up to 12 months when the experiment was terminated. This loss may be attributed to the slight damage on the grain in this type of container.

TABLE 5.—*Mean per cent loss of weight of grains after specified number of months in cotton and gunny sacks*

TREATMENT	COTTON				GUNNY			
	Months				Months			
	3	6	9	12	3	6	9	12
White earth, 5 gm.	0	0.2	0.2	0.8	0	0.4	1.6	2.0
White earth, 10 gm.	0	0	0	0	0.8	1.6	2.4	3.4
Sugar-cane bagasse ash, 5 gm.	0	0	0	0.4	2.6	11.6	16.2	25.4
Sugar-cane bagasse ash, 10 gm.	0	0	0	0.4	0.8	8.4	17.8	22.8
Rice hull ash, 5 gm.	0	0	0	0.2	0.4	6.6	8.2	9.2
Rice hull ash, 10 gm.	0	0	0.4	0.8	1.2	14.6	15.6	22.0
Control	0	0	0.4	1.2	14.6	28.4	32.4	43.0

The mean loss of weight of the grains in the gunny sacks in all treatments including the control increased gradually from the first to the last observation. At 12 months from the start of the experiment, the grains treated with "white earth" lost 2.0 per cent of its weight in the five-gram treatment and 3.4 in the 10-gram treatment. The rice hull ash, the next best, lost 9.2 and 22.0 per cent, and the sugar-cane bagasse ash lost 25.4 and 22.8 per cent, respectively. The control lost 43.0 per cent of its weight at the end of one year. Gay (1949), working on various mineral dusts for the control of grain pests reported that the control or untreated grains weighed 22 per cent less than the treated grains at the end of seven months.

LITERATURE CITED

ALEXANDER, P., J. A. KITCHENER and H. V. A. BRISCOE. 1944. Inert dust insecticides. Ann. Appl. Biol. **31** (2): 143-159.

BRISCOE, H. V. A. 1943. Some new properties of inorganic dusts. Jour. R. Soc. Arts **91** (4650): 593-607.

CHIU, S. F. 1939a. Toxicity studies of the so-called "inert" materials with the bean weevil, *Acanthoscelides obtectus* (Say.). Jour. Econ. Entom. **32**: 240-248.

————. 1939b. Toxicity studies of so-called "inert" materials with the rice weevil and granary weevil. Jour. Econ. Entom. **32**: 810-821.

COTTON, R. T., G. B. WAGNER and T. F. WINBURN. 1942. Insecticidal value of certain dusts for the protection of stored grain. Jour. Kansas Entom. Soc. **15**: 1-6.

FITZGERALD, J. S. 1944. The effectiveness of various mineral dusts for the control of grain pests. Coun. Sci. Industr. Res. (Australia) Bull. **182**: 1-27.

GAY, F. J. 1949. Further test of various mineral dusts for control of grain pests. Rev. Appl. Entom. **37**: 130-131.

GRANDORI, R. 1952. Protection and disinfection of the stored corn through non-toxic substances. Trans. IXth Internatl. Congress Entom. **1**: 849-854.

IYENGAR, A. V. VARADARAJA. 1945. Recent studies of "inert" dust treatment of food-grains. Mysore Agric. Jour. **23** (4): 159-166.

JURADO, A. R. 1942. Silica to protect grains. Rev. Argentina Agron. **9** (1): 1-8.

KRISNAMURTY. 1946. Insects in relation to preservation of food grains. Proc. Soc. Biol. Chrn. India **5** (1): 9-14; *Abs.* in Biol. Abs. **22**: 7606.

LARTER, L. N. H. 1947. Maize seed storage. Trop. Agriculture **24**: 40-44.

LOPEZ, C. 1942. Preservation of stored grain. Bolivia Univ. Nacion. La Plata Fac. Agron. 5: 1-8. Biol. Abstr. **16**: 17126. 1942.

NAGASAWA, SUMIO. 1947. Lethal effect of diatomaceous earth against the asuki-bean weevil, especially its relation to moisture. Bochu-Kogaku **1**: 38-44. Chem. Abstr. **43** (3): 1142e. 1949.

RAO, D. S. 1951. Hints on safe preservation of seed and food grains. Mysore Agric. Jour. **26**: 69-70.

UCHIDA, F. 1945. The use of mineral dusts for the control of wheat pests. Coun. Sci. Industr. Res. (Australia) Bull. 199.

YASUE, YASUNOBU. 1947. Insecticidal action of various pulverized inert dusts. I. Relative toxicities of different-sized particles of silicon carbide to the small rice weevil. Bochu-Kogaku **1**: 45-48. Chem. Abstr. **43** (3): 1142f. 1949.

A SURVEY OF NARIC WAREHOUSES IN LUZON WITH REFERENCE TO THE CONTROL OF STORED GRAIN INSECTS [1]

R. M. Labadan and G. B. Viado [2]

In the 14 NARIC warehouses surveyed in Luzon, 12 species of beetles and four species of moths infesting stored grains were encountered. A predacious bug, hymenopterous parasites, ants, cockroaches, silver-fish, termites, psocids, rats, bats, and house lizards were likewise encountered.

Generally, hygienic conditions in the warehouses were not satisfactory thus favoring the rapid multiplication of the various pests. No pest control practice was employed in all the warehouses surveyed, except at Santiago, Isabela, where a "Bug Master" light trap was installed. This trap, however, did not give any appreciable control. Maintenance of a high standard of warehouse keeping is strongly recommended.

The use of chemical sprays and fumigants can not yet be advocated inasmuch as only meager information on the use of these methods under local conditions is at present available.

Insects cause enormous damage to grains in storage. A conservative estimate of at least five per cent of the grains is lost to insects in three months of storage. Recent studies by these authors [3] showed that shelled corn stored for six months lost about 17 per cent in weight as a result of insect damage. At this length of storage about 75 per cent of the kernels were already damaged by insects.

The proper storage of grains to avoid insect damage has long been a problem of grain producers, processors and handlers in the Philippines. It is deplorable that this problem has not been given the attention it deserves.

OBJECTIVES AND PROCEDURE

The present study was conducted to (1) determine the sources of endemic insect population in the warehouses; (2) determine the

[1] Central Experiment Station Contribution No. 2003. Part of Research Project No. 909 financed by a grant from the NARIC (National Rice and Corn Corporation).

[2] The authors are grateful to the NARIC personnel for their cooperation in the conduct of this survey.

[3] G. B. Viado and R. M. Labadan, *Philippine Agriculturist*, 4, 450-459 (1958).

insect pests, their relative abundance and degree of damage to the grains at the various locations; (3) look into the management practices in the different warehouses and their effects on infestation; (4) note the condition and location of the different warehouses which might influence insect abundance; and (5) observe pest control practices used in each establishment.

The questionnaire used in the survey included the following data: (1) name and location of the warehouse, (2) type of premises, (3) date of inspection, (4) members of the staff interviewed, (5) summary list of grains in storage and their sources of origin, (6) hygienic conditions in the premises, (7) condition of the structure, (8) existence of rodents and other pests, etc.

The survey which covered 14 NARIC warehouses in different places in Luzon was conducted from April to July, 1958.

COMMODITIES STORED IN THE WAREHOUSES

Milled rice was the principal commodity stored in all the warehouses surveyed (table 1). Palay, rice bran, shelled corn, corn grits, corn flour, corn bran, and rice-and-corn grit mix were also stored in some of the warehouses.

The supply of grains in the warehouses came mostly from the neighboring areas, Manila, and other NARIC procuring stations. Of the stations surveyed only Baguio, Manila, Dagupan and Legaspi were not buying stations but were retail or distributing centers. The length of storage of the products in the warehouses depended upon the demand from consumers and the demand in other sections of the country.

ANIMALS FOUND IN THE WAREHOUSES

Insects. Most of the insects found in the warehouses were stored grain insects. The rest were either minor pests, parasites, or predators.

Since all commodities stored in the warehouses were susceptible to the attack of stored grain insects, most of the species of these insects present in this country were found in all the stations surveyed (table 2). The following species were found:

COLEOPTERA

Rice weevil, *Sitophilus oryza* (L.)
Rust-red flour beetle, *Tribolium castaneum* (Herbst.)

Saw-toothed beetle, *Oryzaephilus surinamensis* (L.)
Lesser grain borer, *Rhizopertha dominica* (F.)
Flat grain beetle, *Laemophloeus pusillus* (Schonh.)
Cadelle, *Tenebroides mauritanicus* (L.)
Coffee bean weevil, *Araecerus fasciculatus* (Deg.)
Corn sap beetle, *Carpophilus dimidiatus* (F.)
Siamese beetle, *Lophocateres pusillus* (Klug.)
Foreign grain beetle, *Ahasverus advena* (Walth.)
Cigarette beetle, *Lasioderma serricorne* (F.)
Lesser mealworm, *Alphitobius diaperinus* (Panz.)

LEPIDOPTERA

Angoumois grain moth, *Sitotroga cerealella* (Oliv.)
Rice moth, *Corcyra cephalonica* (Staint.)
Cacao moth, *Ephestia elutella* (Hubn.)
Indian meal moth, *Plodia interpunctella* (Hubn.)

The major species infesting the grains (arranged in descending order) based on the number of warehouses infested were: *Sitophilus oryza, Tribolium castaneum, Alphitobius diaperinus, Corcyra cephalonica, Oryzaephilus surinamensis, Tenebroides mauritanicus* and *Laemophloeus pusillus* (table 2).

Other species of insects found which were either beneficial or minor pests were a predatious bug, *Lyctocoris campestris* Fabr., hymenopterous parasites, ants, cockroaches, silverfish, termites and psocids.

The degree of infestation on the various commodities varied from station to station. Not all the species listed, however, were found in any one warehouse. The only species not found in Camalaniugan, Cagayan, was the foreign grain beetle, *Ahasverus advena.* This species was found only in Ligao, Albay. The coffee bean weevil, *A. fasciculatus* and the cacao moth, *E. elutella,* were found only in Camalaniugan, Cagayan.

Rodents and other animals. Damage due to these pests was not solely the direct feeding on the cereals but the gnawing of the sack containers, causing enormous spillage of the grains. Droppings of these animals were seen mixed with the spilled grains. The woodwork of the buildings was also liable to destruction by these pests.

Other animals observed in warehouses were birds, bats and house lizards. Droppings of these animals contributed to the contamination of the grains.

TABLE 1.—*Summary list of grains in storage at the different warehouses*

DATE SURVEYED	LOCATION OF WAREHOUSE	GRAINS IN STORAGE						MACHINERIES INSTALLED
		Milled rice	Rice bran	Palay	Shelled corn	Corn grit	Rice & corn mix	
April 22, 1958	Cabanatuan City	x		x	x	x		Rice Mill
23	Solano, Nueva Vizcaya	x		x	a			Rice Mill [b]
23	Santiago, Isabela	x	x	x	x			
25	Camalaniugan, Cagayan	x	x	x	x	x		Rice and Corn Mills
29	Baguio City	x						
29	Dagupan City	x					x	
30	Castillejos, Zambales	x		x				Rice Mill
May 19	Pureza, Manila	x						Mixing machines [c]
June 6	Legaspi City	x				x	x	
6	Sorsogon, Sorsogon	x					x	
7	Ligao, Albay	x	x		a			Rice Mill
9	Daet, Camarines Sur	x					x	
10	Naga, Camarines Norte	x	x	x	x			Rice Mill
July 29	Pureza, Manila (whse 1-E)	x			x	x		

[a] Corn is procured but brought directly to Manila for shipment to consumers.
[b] Rented by NARIC.
[c] Imported and native rice were mixed in these machines before marketing.

TABLE 2.—*Distribution of the various species of stored grain insects in the different warehouses*

SPECIES	LOCATION OF WAREHOUSE [a]													
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Coleoptera														
S. oryza	x	x	x	x	x	x	x	x	x	x	x	x	x	x
T. castaneum	x	x	x	x	x	x	x	x	x	x	x	x	x	x
O. surinamensis	x	x	x	x		x	x	x	x	x	x		x	
R. dominica	x			x		x								
L. pusillus	x	x		x						x	x			x
T. mauritanicus	x	x	x	x			x	x	x	x	x		x	x
A. fasciculatus				x										
C. dimidiatus	x			x										
Lop. pusillus	x			x										
A. advena											x			
L. serricorne	x			x				x						
A. diaperinus	x			x	x	x	x	x	x	x	x	x	x	x
Lepidoptera														
S. cerealella	x		x	x	x									
C. cephalonica	x	x	x	x	x		x		x	x	x	x	x	x
E. elutella				x										
P. interpunctella	x			x										

[a] 1—Cabanatuan
2—Solano
3—Santiago
4—Camalaniugan
5—Baguio
6—Dagupan
7—Castillejos
8—Manila
9—Legaspi
10—Sorsogon
11—Ligao
12—Daet
13—Naga
14—Manila (I-E)

CONDITIONS OF THE WAREHOUSES AND PREMISES

The warehouses at Cabanatuan City and Camalaniugan, Cagayan, were the biggest. Nearly all the warehouses had concrete foundation and floors. However, cracks on the walls and floors and leaky roofs in some of the warehouses indicated that these structures were already old and had not been repaired for some time. New modern bins, warehouses and other structures were being built in some of the stations surveyed.

Generally, hygienic conditions in the warehouses were not satisfactory. Reasons given by warehouse keepers were either one or a combination of situations such as lack of personnel, lack of facilities and large volume of daily business transactions. Old insect-infested accumulations of grains, grain products and dust were found in floor and wall cracks, corners, floor-wall angles, under wooden pallets or mixed with rice hull used as dunnage, and under equipment and piles of odds-and-ends stored in the building. In warehouses where rice or corn milling machineries were installed ceilings, walls, equipment and piles of sacked grains were covered with thick dust from the milled grains.

Rough handling of sacks in transit and damage on sack containers by rodents resulted in heavy spillage of grains in all the warehouses. The accumulated spillage on the floor which was swept, sacked and re-milled before being marketed, contained dust, insects, droppings of rodents, birds and house lizards and odd mixture of debris.

SOURCES OF INFESTATION

There were four major sources of infestation of the stock in storage, namely, (1) infested-grain and grain-product accumulations in cracks, crevices, corners, under pallets, etc., in the warehouse, (2) undisposed old stocks, (3) spillage swept from the floor, sacked and stored in the warehouse, and (4) infested material brought in for storage. Used sacks piled in some corners of warehouses yielded small amount of badly infested grain or grain products.

OTHER OBSERVATIONS

No pest control was practised in the warehouses except at Santiago, Isabela, where a "Bug Master" light trap was installed. Very few moths and beetles were found in the trap at the time of the survey.

Wooden pallets were used to protect the sacks from excessive moisture from the floor surface. In Solano, Nueva Vizcaya, and Santiago, Isabela, rice hull was used either as supplementary dunnage or in place of the wooden pallets. Both kinds of dunnage provided not only hiding places for insects but also spaces for grains or grain products to accumulate.

Of the 14 stations surveyed, five had installed rice mills, one had both rice and corn mills and another a mixing mill. Palay was milled only as needed; this practice diminished infestation of the milled rice.

The "Chinese method" of piling sacks which allows for aeration of the sacks was employed in the warehouses surveyed. In some warehouses the piles were kept too close to the walls thereby making inspection difficult.

RECOMMENDATIONS FOR MAINTAINING A HIGH STANDARD OF WAREHOUSE KEEPING

The following recommendations, while they may not apply to all premises, may be adopted to suit a particular situation.

1. Articles such as empty sacks and other containers, pieces of dunnage and parts of machineries should be removed from the storage room. Spillage of grains and old infested stocks should be disposed of as soon as possible. Grain sweepings should be screened from dusts, insects, and fine trash and the screenings burned to kill insects therein.

2. Thorough cleaning by brushing to remove residues and dusts, paying particular attention to upper surfaces of beams, crevices, window sills, corners, and floor-wall angles should be done as frequently as possible. When feasible, a vacuum cleaner should be used in removing dusts, residues and insects from corners or crevices which could not be cleaned otherwise. Structural cracks and crevices should be filled with concrete or any suitable material to prevent grain or grain products from collecting and harboring insects therein.

3. New stocks should be stacked neatly with adequate headroom and gangways for easy inspection. Priority should be given to old stocks in the disposal of the grains to minimize the danger of being the source of infestation for the coming new stocks.

The use of chemicals for the treatment of grains against insect pests in this country need careful study and consideration inasmuch

as these cereals are used directly for human consumption without further processing. Furthermore, conditions existing in this country are different from those in countries where this method was reported effective. The absence of laws regulating the use of insecticides on foods and food products in the Philippines renders the problem of chemical control more complicated.

Fumigation is one of the quickest methods of controlling infestation of stored grains by insect pests. However, this method can not be recommended under the present situation because none of the warehouses surveyed meets the specifications required for this method of control. Furthermore, the warehouses are located in or near residential districts, thereby rendering fumigation impossible without endangering lives.

MARKETING CORN AT THE FARM LEVEL IN THE PHILIPPINES, 1956–1957 [1]

BENJAMIN D. PEREDO

The average size of farm in the six provinces studied was 3.4 hectares. However, the effective crop area planted to corn was 4.0 hectares, which was 0.6 hectare greater than the average size of farm.

The average quantity sold per farmer was 32 cavans shelled corn. On the average, Cotabato farmers sold 88 cavans each and Cebu farmers, two cavans each of shelled corn.

For all farmers, the average number of sales was 2.6. Corn was sold in various forms and in different units of sales such as by the kerosene can, by the kilo, by the basket, by the cart, and by the hundreds of ears. Corn sold in husked form by the cavan constituted 53 per cent, the largest proportion of the total quantity marketed.

Of the farmers surveyed, 42 per cent sold their corn within one to two months after harvest. About one-third of the farmers sold corn at or near harvest time and about one-fourth within three to four months after harvest time.

The three peaks of corn marketing noted were in the months of January, April and November.

The most important outlet in selling corn was private wholesalers. Sales direct to consumers was the second most important outlet.

The field or the farmers' home lot was the most common place at which farmers sold corn. The roadside ranked second.

The average price received for shelled corn was ₱8.08 per cavan. Batangas farmers received the highest price of ₱10.92 per cavan; Cotabato farmers received the lowest, ₱6.89 per cavan. The highest prices were reported in May and September whereas, lowest prices were reported in November and June. The retailers paid the highest price of ₱10.11 per cavan of shelled corn and the farmers paid the lowest price of ₱5.81 per cavan.

The marketing margin in the six provinces ranged from a low of ₱2.77 per cavan shelled corn in Isabela to a high of ₱5.10 in Negros Oriental.

Information on corn prices was most often obtained from corn buyers and public markets.

---

[1] Central Experiment Station Contribution No. 2004. Part of Research Project No. 1114 financed by a grant from the NARIC. Prepared in the Department of Agricultural Economics under the direction of former Visiting Cornell Professor Lawrence B. Darrah.

The cost of marketing a cavan of shelled corn by farmers averaged ₱0.80. The non-cash costs constituted ₱0.69 or about 86 per cent of the total and the cash or kind cost was ₱0.11 or 14 per cent.

The most important problems of the corn farmers were: low prices, lack of storage facilities, lack of reliable information on market prices, lack of uniform weights and measures for the sale of corn, absence of good transportation facilities and need for shelling machines.

Corn is grown extensively throughout the Philippines. From 1948 to 1955, there was a continuous increase in the area planted to corn (fig. 1). As a result, corn production increased substantially up to 1952. In 1955, corn was grown on 1.3 million hectares

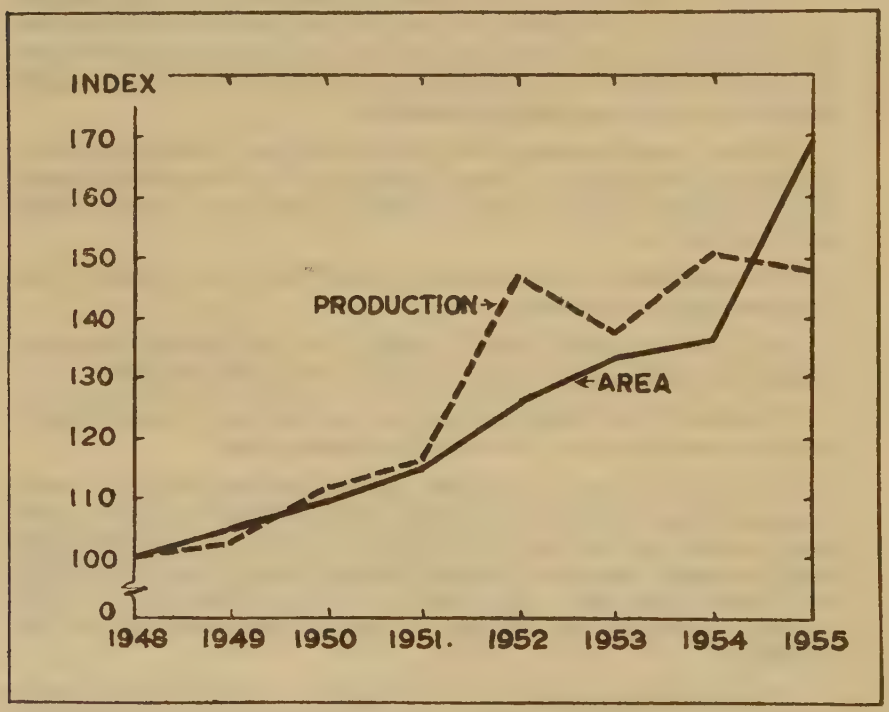

Fig. 1.—Index of Area Planted and Production, Philippines, 1948-1955 (1948 = 100). Source: Division of Agricultural Economics, Department of Agriculture and Natural Resources, Manila.

with a proportion of 13.5 million cavans (57 kilograms to a cavan) of shelled corn. Production by provinces ranged from 1,300 cavans in Batanes to 2,013,000 cavans in Cebu. The other leading provinces, besides Cebu were Isabela, Leyte, Cotabato, Davao, Negros

Oriental, Negros Occidental, Batangas, Zamboanga del Sur, Misamis Oriental, Misamis Occidental and Cagayan. Although Cebu and Leyte produced the first and third largest quantities during the period under consideration, the average yield per hectare in these provinces was only about eight cavans compared to an average yield of 16 cavans in Isabela, Cotabato and Davao.

Corn is produced to meet the demands of the corn-eating population which makes up about 20 per cent of the people in the Philippines [2] and of industries that use corn for brewing and in the manufacture of corn starch and poultry feed. As a staple food crop it ranks second to rice. The bulk of the corn-consuming population lives in the Visayan provinces, particularly Cebu, Bohol, Negros Oriental and Leyte and in the Northern Mindanao provinces of Bukidnon and Lanao.

According to Salanga,[3] the demand for corn for consumption and industrial purposes has steadily increased. The demand for feed purposes increased yearly by 12.5 per cent. About one per cent of the total annual production from 1949 to 1953 and 2.2 per cent in 1954 and 1955 were used for industrial purposes.

Because of the importance of corn in the Philippine economy, the government has lately created incentives to promote corn production and marketing. In 1954 [4] the following recommendations were made in favor of the corn producers: (1) stabilization of prices, and (2) effective extension of credit through the FaCoMas (Farmers' Cooperative Marketing Associations). This study was conducted to have a better understanding of the marketing of this crop through research. It is believed that improved production and an efficient marketing system will aid in improving the corn farmers' way of living through increased income.

The study was specifically designed to obtain a clear picture of the marketing of corn for the crop year 1956-1957 in the major corn-producing areas of the Philippines. It consisted of four major phases, namely: (1) marketing of corn by farmers, (2) operations of corn wholesalers, (3) corn milling operations and (4) corn retailing.

---

[2] Luciano Salanga, *Monthly Review of Philippine Business Condition*, Manila (1956).
[3] *Ibid.*
[4] *Ibid.*

This report which deals with the first phase of the study includes information on the following: (1) marketing practices followed, (2) time of sales, (3) market outlets used, (4) cost of marketing services performed, and (5) prices obtained and net returns from different marketing procedures and market outlets.

Data in this study were obtained from interviews with 372 corn farmers, 28 wholesalers, 16 corn millers and 30 corn retailers in the six leading corn-producing provinces of Batangas, Isabela, Davao, Cotabato, Cebu, and Negros Oriental. Only farmers who had marketed corn were included in the study. This resulted in a larger average size of farm, a higher production per farm and larger sales per farm than the average for all corn producers.

THE FARMER AND THE FARM

Tenure status of farmers. Of the 372 farmers surveyed, 49 per cent were tenant-operators. Owner-operators made up 42 per cent of the total. Only nine per cent of the farmers interviewed were part-owners.

Of the farmers interviewed, the proportion of tenant-operators was highest in Cebu and Davao; the proportion of owner-operators was highest in Isabela, Negros Oriental, and Batangas. Part-owner operators were relatively most important in Batangas and Isabela.

Size of farm. The average size of farm in the six provinces studied was 3.4 hectares (table 1). Farm size ranged from 1.2 hec-

TABLE 1.—*Size of farm and area planted to corn* [a]

PROVINCE	NUMBER OF FARMS	SIZE OF FARM			ALL	LAND AREA PLANTED TO CORN
		Owner	Part-owner	Tenant		
		hectares				
Batangas	48	5.1	3.8	3.5	4.4	3.4
Isabela	75	2.6	3.3	2.8	2.4	2.6
Davao	61	7.7	3.5	2.4	3.6	6.1
Cotabato	60	7.4	5.5	2.8	5.0	7.0
Cebu	62	1.4	2.6	1.1	1.2	2.8
Negros Oriental	66	6.0	2.2	1.2	3.8	2.5
All	372	5.0	3.4	2.0	3.4	4.0

[a] In this and succeeding tables data cover 372 corn farms in the Philippines for the crop year 1956-1957 except as otherwise indicated.

tares in Cebu to 5.0 hectares in Cotabato. Owner-operators had farms that averaged 5.0 hectares in size; part-owners, 3.4 hectares; and tenants, 2.0 hectares.

On many of the farms studied, farmers rotated corn with palay, legumes, vegetables, sugar cane, tobacco and other crops. Also, many farmers utilized only a section or a few sections of the field for corn, retaining the rest for the next planting season. This explains why the average area planted to corn in Batangas and Negros Oriental was lower than the total farm area. The fact that many farmers raised two to three crops annually explains why the total area planted to corn in Isabela was very low. The size of farm in Davao, Cotabato and Cebu was higher than the average during the crop year 1956–1957. The average land area planted to corn on all farms surveyed amounted to 4.0 hectares, which was 0.6 hectare greater than the average size of farm. Davao and Cotabato farmers had the largest cropping areas during the period under consideration.

Varieties raised. The kind of corn raised depends largely upon demand within the province and in the neighboring provinces. White corn is generally preferred to red corn for human consumption. Red corn is used more for poultry feed purposes.

In Batangas and neighboring provinces, corn is not a staple food, although young corn is eaten in boiled or broiled form. Hence, 62 per cent of the Batangas farmers raised red corn which has a good market as feed in Manila. In the other five provinces, farmers raised only white corn for local consumption or shipment to other corn-eating provinces.

Production. The average production per farm was about 63 cavans of shelled corn (table 2). This ranged from 19 cavans per farm in Cebu to 135 cavans per farm in Cotabato. Total production, however, is a result of hectarage planted and yield per hectare. The average yield for all farms was about 16 cavans per hectare. Yields were lowest in the Cebu and Negros Oriental areas with about seven to eight cavans per hectare. Highest yields per hectare were reported in Isabela, Davao, and Cotabato with about 19 to 20 cavans per hectare.

After deducting the harvesters' and landlords' shares from the total production and adding the operators' share from other farms, corn farmers had an average of 48 cavans of shelled corn left for their use. The average farmer in Cotabato had more than 100 cavans

left; in Davao, more than 80 cavans. In contrast, the average farmer in Cebu had only nine cavans left; in Negros Oriental, 15 cavans. This would indicate that corn marketing by farmers would be much more important in the Davao and Cotabato areas than in the Cebu and Negros Oriental areas.

TABLE 2.—*Production and shares of the landlord and tenant*

ITEM	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
Number of farms	48	75	61	60	62	66	372
				cavans shelled corn			
Production per farm	43	51	115	135	19	20	63
Yield per hectare	12.5	19.8	18.8	19.4	6.6	8.1	15.8
Harvesters' share	1.5	0.6	15.0	26.6	1.9	1.7	7.7
Landlords' share	3.9	4.9	18.6	12.8	7.9	2.9	8.4
Operators' share	37.3	45.5	80.9	95.3	8.9	15.4	46.5
Operators' share from other farms	—	—	1.2	9.1	—	—	1.7
Total operators' share	37.3	45.5	82.1	104.4	8.9	15.4	48.2

Disposal of operators' share. The average corn farmer sold 66 per cent of his share of the corn crop, amounting to about 32 cavans (table 3). The second largest proportion of the operators' share,

TABLE 3.—*Disposal of operators' share*

ITEM	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
Number of farms	48	75	61	60	62	66	372
Average operators' share	37.3	45.5	82.1	104.4	8.9	15.4	48.2
				per cent			
Disposal							
Family consumption	9	35	20	11	70	70	23
Seed	3	1	1	2	6	3	2
Feed	16	18	2	3	1	1	7
Debts	[a]	[a]	3	—	[a]	—	[a]
Sold	71	39	74	84	23	27	66
Given away	1	7	—	[a]	—	—	2
Total	100	100	100	100	100	100	100

[a] Less than one per cent.

23 per cent, was used for family consumption. Small quantities were either used for feeds and seed or given away.

The manner in which the corn crop was disposed varied widely from one province to another. In Cebu and Negros Oriental, 70 per cent of the operators' share was kept for family consumption and only one-fourth was sold. In the Mindanao provinces and in Batangas, the reverse was true; about 70 to 80 per cent of the crop was sold and approximately 10 to 20 per cent kept for home consumption. In Isabela, the proportion sold was only slightly greater than that kept for home use. The average proportion (17 per cent) used for livestock feed in Batangas and Isabela was greater than in the other four provinces.

Young corn is not as important as mature corn as a staple food or as source of income. However, some young corn was harvested by 345 of the 372 farms studied. The average number of corn ears harvested on these farms was 1160 per farm (table 4). Batangas farmers reported that they had sold 38 per cent of their young corn at ₱0.02 per ear. In the other five provinces the harvested young corn was consumed in boiled or broiled form at or between meals.

TABLE 4.—*Disposal of operators' share of young corn in 345 corn farms, 1956–1957*

ITEM	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
Number of farms	41	72	55	50	61	66	345
Operators' share, ears	2,033	764	411	871	588	2,419	1,160
				per cent			
Disposal							
Family consumption	46	100	100	100	100	100	89
Feed	14	—	—	—	—	—	3
Sold	38	—	—	—	—	—	8
Given away	2	—	—	—	—	—	[a]
Total	100	100	100	100	100	100	100

[a] Less than one per cent.

MARKETING PRACTICES

Pre-marketing practices

Marketing operations at the farm level were considered to start at harvest time. Farmers reported a number of pre-sale practices

such as husking, drying, storing, shelling, packaging and transporting in the marketing of corn. These practices varied from one province to another. Many farmers, however, reported that the differences in the marketing practices were due to time of harvesting which in turn depended upon the maturity of the corn crop and weather conditions, prices prevailing in the community, need for cash, availability of marketing facilities and convenience of performing the marketing jobs.

Husking. About 60 per cent of the farmers reported that husking was performed in the field immediately after harvesting the corn (table 5). The rest of the farmers husked corn in their home lot after it was hauled from the field either by cart or carried by men. Husking practices, however, varied widely from area to area.

TABLE 5.—*Husking and drying practices*

METHOD	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
	per cent of farms reporting						
Husking:							
In field	45	1	72	100	51	97	59
In home lot	55	99	28	—	49	3	41
Special drying:							
None	22	100	98	97	100	71	79
In field	41	—	—	—	—	—	8
In home lot	29	—	2	3	—	29	11
On bamboo rack	8	—	—	—	—	—	2
Length of drying, days	3.3	—	2.0	1.1	—	3.2	3.1

Drying. In general, special drying of corn was not widely practised. For all provinces, about 80 per cent of the farmers reported no special drying. This proportion of farmers, however, includes an undetermined number who let corn which was ready for harvesting dry on the stalks while still standing in the field. Batangas and Negros Oriental farmers did more special drying than those in other provinces. Forty-one per cent of the total reporting Batangas farmers dried corn in the field by leaving it in stockpiles. Drying in the field was usually done during the dry season. Nearly a third of the Batangas and Negros Oriental farmers reported that corn was dried in the home lot either on "buri" (palm) mats or swept ground. The length of the drying period averaged three days.

Storing. Storing practices for corn varied widely. About one-third of the farmers reported storing the corn after harvesting while nearly as many reported storing it after husking (table 6). Storing of corn was most widely practised in Batangas and Isabela and least widely practised in Davao and Cotabato.

TABLE 6.—*Storing practices*

METHOD	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
	per cent of farms reporting						
Time of storage:							
Did not store	—	—	45	83	35	32	31
After harvesting	4	97	9	—	53	4	31
After husking	66	3	46	15	12	29	27
After drying	30	—	—	—	—	35	11
After shelling	—	—	—	2	—	—	[a]
Place of storage:							
House	94	11	71	91	98	100	68
Barn	6	89	27	9	23	—	32
FaCoMa warehouse	—	—	2	—	—	—	[a]
Containers used:							
Gunny sacks	18	—	35	31	—	2	11
Loosely stored	82	100	65	69	100	98	89
Length of storage, months	1.6	2.5	1.2	0.9	1.3	2.4	1.9

[a] Less than one per cent.

The most frequently used place of storage for corn was the farmers' house. This place of storage was reported by two-thirds of the farmers. In Isabela and to a much lesser extent in Davao and Cebu, corn was stored in barns. The general practice was to store the corn loose. However, farmers in some areas packed the corn in gunny sacks. The average length of time corn was stored was about two months.

Shelling. Shelling of corn was primarily performed by hand with a small hand tool. The use of hand or motor-operated shellers was most common in Batangas, Davao and Cotabato (table 7). Shelling by hand was the only method used in the other provinces studied.

TABLE 7.—*Shelling and packaging practices*

METHOD	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
	per cent of farms reporting						
Shelling:							
Hand with tool	46	93	40	43	100	100	84
Machine [a]	54	7	60	57	—	—	16
Packaging done by:							
Farmer	64	88	85	70	100	100	85
Buyer with laborers	18	12	13	23	—	—	11
Both	18	—	2	7	—	—	4
Container provided by:							
Farmer	70	45	7	—	100	100	58
Buyer	30	55	93	100	—	—	42

[a] Hand and motor operated.

Transportation facilities were most frequently provided by the corn buyers (table 8). This procedure was reported by about half of the farmers. One-fourth of the farmers reported that they furnished the transportation while nearly as many stated that the transportation was hired.

TABLE 8.—*Transporting corn to market*

ITEM	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
	per cent of farms reporting						
Facilities provided by:							
Buyers	—	4	88	95	—	—	52
Farmers	40	81	9	5	—	33	25
Hired	60	15	3	—	—	67	23
Type of facility:							
Motor vehicle	67	11	93	95	—	—	59
Animal-drawn cart	27	82	—	5	—	—	15
Horseback	6	—	3	—	—	—	1
Boat	—	7	—	—	—	—	1
Men's shoulder	—	—	4	—	—	100	24

Characteristics of sales

Volume sold. The total volume sold by the farmers surveyed in the six provinces for the crop year 1956–1957 amounted to 11,948 cavans shelled corn. The average quantity sold per farmer was 32 cavans shelled corn (table 9).

TABLE 9.—*Total volume sold*

PROVINCE	TOTAL VOLUME SOLD	PERCENTAGE OF TOTAL VOLUME SOLD	VOLUME SOLD PER FARMER
	cavans shelled corn	*per cent*	*cavans shelled corn*
Batangas	1,267	11	26.5
Isabela	1,358	11	17.7
Davao	3,724	31	60.7
Cotabato	5,252	44	87.7
Cebu	129	2	2.1
Negros Oriental	269	2	2.1
All	11,948	100	32.0

Cotabato and Davao farmers sold the largest volume and Cebu and Negros Oriental farmers, the smallest.

On the average, Cotabato farmers sold 88 cavans of shelled corn each and Davao farmers, 61 cavans. Conversely, farmers in Cebu sold an average of only two cavans of shelled corn each and farmers in Negros Oriental, four cavans. Farmers in Batangas sold an average of about 27 cavans each or 10 cavans more than the average for Isabela farmers.

Number of sales. For all farmers, the average number of sales was 2.6. Davao and Batangas farmers had the highest number of sales; Cebu and Isabela farmers, the lowest (table 10). Most of the farmers raised two or three crops of corn during the year, hence, the majority of them made two or three different sales. A few farmers sold corn only once a year; approximately as many made four or more sales.

Unit of sale. Corn was sold in various forms and in different units of sales. Husked corn was sold by the kerosene can in three provinces and by the cavan containing a given number of kilos in two provinces. Unhusked corn was sold by the basket, by the cart, and by the hundreds of ears. Shelled corn was sold in numerous ways, too. It was commonly sold by the cavan containing a given number of piculs, by the ganta and by the can.

Corn sold in husked form by the cavan constituted the largest proportion, 53 per cent, of the total quantity marketed. About one-fourth of the total quantity was sold in shelled form, also by the cavan. A substantial amount of husked corn was sold by the can and of shelled corn by the cavan containing a given number of piculs.

TABLE 10.—*Number of sales in disposing of crop and proportion of total volume sold*

NUMBER OF SALES	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
Average number of sales	2.9	2.4	3.1	2.7	2.0	2.7	2.6
	per cent of farmers						
One	11	20	—	—	22	15	12
Two	35	40	18	28	55	48	38
Three	23	10	72	72	23	18	35
Four	19	17	2	—	—	6	7
Five or more	12	13	8	—	—	13	8
Total	100	100	100	100	100	100	100
	per cent of volume sold						
One	4	12	—	—	16	28	2
Two	43	29	17	21	52	35	24
Three	17	12	67	79	32	18	60
Four	20	16	6	—	—	8	6
Five or more	16	31	10	—	—	11	8
Total	100	100	100	100	100	100	100

Cotabato farmers sold the bulk of their corn in husked form by the cavan; Isabela, Cebu and Negros Oriental farmers sold corn shelled, also by the cavan. Batangas farmers sold about half of their mature corn in husked form and the balance in shelled form by the same method employed by the Cotabato, Isabela, Cebu and Negros Oriental farmers. In Davao, the amount sold in husked form by the cavan and in shelled form containing a given number of piculs constituted the bulk of the total volume.

Time of sales. Of the farmers surveyed, 42 per cent sold their corn within one to two months after harvest (table 11). The proportion which sold corn three to four months after harvest time amounted to 17 per cent. Practically none of the farmers stored their corn for more than four months. The majority of the farmers in Batangas sold corn within one to two months. In Isabela, the proportion of the farmers who sold corn within three to four months was higher than that of those who sold within one to two months.

In Davao and Cotabato, the majority of the farmers sold their corn at or near harvest time. In Cebu, the number that sold corn at or near harvest time was about equal to the number that sold within one to two months. In Negros Oriental, the bulk of the farmers sold corn within one to two months. About one-third of the farmers sold corn at or near harvest time and about one-fourth within three to four months after harvest time.

TABLE 11.—*Time of sales*

TIME OF SALES	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
	per cent of farmers						
At or near harvest time	14	2	57	89	48	32	39
1 month later	68	41	36	11	49	46	42
3–4 months later	13	51	5	—	3	22	17
5–6 months later	5	2	2	—	—	—	1
7–12 months later	—	4	—	—	—	—	1
Total	100	100	100	100	100	100	100

Agricultural production varies from year to year mainly because of the weather. This factor and seasonal patterns in corn harvesting and sales in the six provinces necessitate some adjustments in the time of sale for all provinces so that data would be more comparable. For this study the marketing year considered was from November, 1956, to October, 1957.

For all provinces, three peaks were noted in corn sales (table 12). The first and third peaks were more distinct than the second. The first peak started in January. Sales reached another peak in April when about 12 per cent of the total volume of sales for the year was made. Thereafter, sales declined and reached a low of five per cent in August, but went up again in September. This was considered the second peak of sales. Sales declined in October but picked up again in November. The increase in volume of sales in November marked the start of the third marketing period. The following month, the highest peak of sales during the year, represented by 17 per cent of the total volume of sales, was reached. Months of high and low sales varied from one province to another.

TABLE 12.—*Volume of sales by month*

MONTH	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
	per cent of volume sold						
November, 1956	3	24	7	9	8	13 [b]	10
December	1	19	25	13	2	2	17
January, 1957	1	3	4	3	9	3	4
February	2	1	5	6	1	[c]	5
March	28	[c]	5	11	—	2	10
April	14	5	10	13	17	12	12
May	10	4	1	14	8	7	9
June	[c]	6	11	6	1	16	7
July	3	14	7	9	—	5	8
August	1	—	4	7	21	24	5
September	20 [a]	1	17	4	10	9	9
October	17 [a]	23 [a]	4	5	23	7	4
All	100	100	100	100	100	100	100

[a] Volume of sales in 1956.
[b] Volume of sales in 1957 was excluded in the computation for all provinces.
[c] Less than one per cent.

Marketing outlets. The most important outlet in selling corn was private wholesalers (table 13). Sales direct to consumers was the second most important outlet and sales to agent buyers and retailers were next in importance.

TABLE 13.—*Market outlets used by farmers and proportion of total volume sold*

MARKET OUTLET	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
	per cent of farmers						
Consumers	2	—	—	2	65	48	21
Retailers	4	3	—	2	33	50	17
Wholesaler-retailers	8	—	—	2	—	—	1
Wholesalers:							
Private	76	44	72	54	2	—	38
FaCoMa	—	—	8	4	—	—	2
NARIC	—	1	—	33	—	—	1
Agent buyers	—	1	—	33	—	—	1
Neighbors	—	5	—	—	—	—	1
Total	100	100	100	100	100	100	100

			per cent of volume sold				
Consumers	1	—	—	[a]	58	50	2
Retailers	4	2	—	1	34	44	2
Wholesaler-retailers	8	—	—	2	—	4	2
Wholesalers:							
Private	75	52	69	56	8	—	60
FaCoMa	—	—	10	2	—	—	4
NARIC	—	4	—	1	—	—	1
Agent buyers	12	36	21	38	—	2	28
Neighbors	—	6	—	—	—	—	1
Total	100	100	100	100	100	100	100

[a] Less than one per cent.

Place of sale. The field or the farmers' home lot was the most common place at which farmers sold corn (table 14). Nearly half of all farmers made their sales at this point. Sales at the roadside the roadside ranked second. Sales made at the wholesalers' ware- ranked second. Sales made at the wholesalers' warehouse, at the public markets, and at retail stores ranked third.

TABLE 14.—*Place of sales and proportion of total volume sold*

PLACE	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
			per cent of farmers				
Field and/or farmstead	70	66	40	55	41	26	48
Roadside	5	12	9	32	55	21	22
Public market	21	1	—	1	1	24	9
Retail store	2	10	3	2	3	25	9
Wholesale warehouse	2	11	39	10	—	—	10
Wholesaler-retailer store	—	—	—	—	—	4	1
Mill	—	—	9	—	—	—	1
Total	100	100	100	100	100	100	100
			per cent of volume sold				
Field and/or farmstead	26	66	41	68	37	26	56
Roadside	26	18	8	13	59	20	13
Public market	42	1	—	1	3	20	2
Retail store	4	6	2	10	1	32	7
Wholesale warehouse	2	9	37	8	—	—	18
Wholesaler-retailer store	—	—	—	—	—	2	[a]
Mill	—	—	12	—	—	—	4
Total	100	100	100	100	100	100	100

[a] Less than one per cent.

Price comparisons are more meaningful if they are converted to a per-cavan-of-shelled-corn basis, as shown in table 15. The average price received for corn was ₱8.08 per cavan. Highest prices were obtained for shelled corn and lowest prices for unhusked corn.

TABLE 15.—*Weighted average price per cavan shelled corn by kind and form of corn sold*

KIND OF PRODUCT & METHOD OF SELLING	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
				pesos			
Husked:							
Per can	8.61	—	8.92	9.56	—	—	8.77
Per cavan, kg.	—	—	7.62	6.63	—	—	6.89
Unhusked:							
Per basket (gappa)	—	7.49	—	—	—	—	7.49
Per cart	—	5.00	—	—	—	—	5.00
Per hundred ears	—	—	—	—	6.96	—	6.96
Shelled:							
Per cavan, kg.	13.04	8.30	—	8.64	9.14	9.89	9.78
Per cavan, picul	—	—	10.10	—	—	—	10.10
Per ganta	—	—	—	—	7.86	9.90	9.49
Per can	—	8.00	—	—	—	—	8.00
Ground, per cavan	—	—	—	9.00	—	—	9.00
All	10.92	8.20	8.58	6.89	8.68	9.90	8.08

Provincial comparison of prices for shelled corn shows that Batangas farmers received the highest price of ₱10.92 per cavan. This was followed by an average price of ₱9.90 received by Negros Oriental farmers. The lowest average price, ₱6.89 per cavan, was reported by Cotabato farmers.

Monthly prices. Prices fluctuated widely during the year under consideration. Table 16 and figure 2 show that highest prices were reported in May and September whereas, lowest prices were reported in November and June. There was a minor price peak in January.

In general, no close relationship between volume of sales and prices existed (fig. 2). During some months, volume of sales went up and prices down; during other months, volume of sales went down and prices dropped. There were also months when volume of sales

TABLE 16.—*Monthly prices per cavan of shelled corn*

MONTH	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
				pesos			
November, 1956	12.95	8.10	8.06	6.59	9.74	10.92	7.63
December	9.19	7.88	8.02	5.90	7.00	12.00	7.26
January, 1957	15.00	6.09	9.51	8.01	9.79	9.83	7.26
February	11.52	7.75	8.59	7.02	11.12	10.00	8.11
March	9.30	8.33	9.79	6.05	—	10.83	7.72
April	13.93	9.62	9.65	7.64	4.35	9.77	9.11
May	13.08	8.47	11.11	9.44	8.20	9.32	9.93
June	7.12	9.07	7.57	4.98	11.00	12.26	7.07
July	—	8.94	9.11	5.64	—	11.82	8.06
August	8.98	—	8.30	7.30	7.49	8.95	7.83
September	9.99	7.56	9.85	7.20	8.54	9.41	9.17
October	9.75	7.52	8.95	6.48	9.10	10.25	7.56
All	10.92	8.20	8.58	6.89	8.68	9.90	8.14

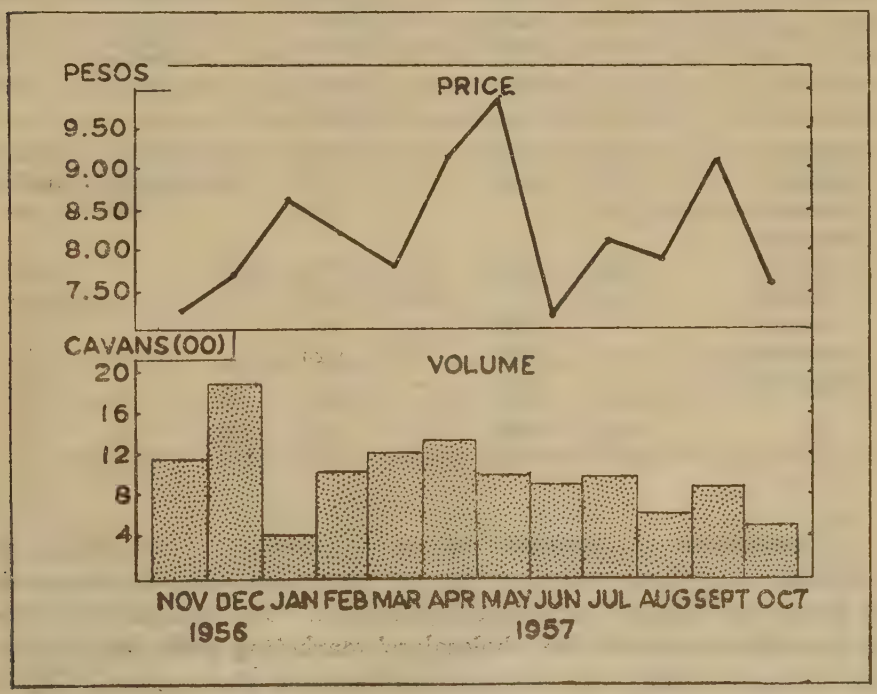

Fig. 2.—Monthly prices and volume sold, 372 corn farms, Philippines, 1956-1957

moved up and prices rose. This simply means that production and marketing of corn in the provinces outside the six ones studied had more effect on prices than local production at certain times of the year.

Prices received by type of buyer. In all provinces studied, the retailers paid the highest price of ₱10.11 per cavan of shelled corn (table 17). Consumers paid the next highest price. Neighbors of the farmers paid the lowest price, an average of ₱5.81 per cavan. However, prices reported as received from the various outlets already discussed are not too significant because the volume of sales to such agencies was quite small. Prices paid by private wholesalers and agent buyers are more important to consider because 60 per cent of the total volume of corn sold was channeled to the wholesalers and a little less than 30 per cent to the agent buyers.

TABLE 17.—*Average price received per cavan shelled corn by type of buyer*

MARKET OUTLET	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
				pesos			
Consumers	12.93	—	—	18.00	8.29	9.61	9.59
Retailers	9.73	10.59	—	7.62	9.44	11.36	10.11
Wholesaler-retailers	8.80	—	—	6.19	—	7.50	7.46
Wholesaler:							
Private	11.28	8.24	7.72	6.55	7.37	—	7.75
FaCoMa	—	—	9.14	5.32	—	—	8.39
NARIC	—	7.47	—	—	—	—	—
Agent buyers	9.62	8.50	8.92	6.23	—	10 00	7.32
Neighbors	—	5.81	—	—	—	—	5.81
All	10.92	8.20	8.58	6.89	8.68	9.90	8.08

Comparison of wholesale and farm prices. A comparison of wholesale and farm prices in the six provinces studied was made to obtain an idea of the marketing margin. The margins of price differentials represent the wholesalers' marketing costs plus profits. Marketing margin in the six provinces ranged from a low of ₱2.77 per cavan shelled corn in Isabela to a high of ₱5.10 in Negros Oriental (table 18).

TABLE 18.—*Comparison of wholesale and farm prices*

PROVINCE	WHOLESALE PRICE [a]	FARM PRICE [b]	GROSS MARGIN
	pesos per cavan shelled corn		
Batangas	14.39	10.92	3.47
Isabela	10.97	8.20	2.77
Davao	11.77	8.58	3.19
Cotabato	9.94	6.89	3.05
Cebu	11.63	8.68	2.95
Negros Oriental	15.00	9.90	5.10

[a] Selling price of the wholesalers. Data used for Batangas, Isabela, Davao and Cotabato were obtained from 26 corn wholesalers during the period of survey whereas, that in Cebu and Negros Oriental were obtained from "Report on Prices of Palay, Rice and Corn," September, 1957, National Rice and Corn Corporation, Philippines.

[b] Average prices received by farmers included in survey.

Sources of price information. Information on corn prices was most often obtained from corn buyers (table 19). This source of price information was mentioned by over 40 per cent of the farmers. About one-fourth of the farmers obtained price information from the public markets, and nearly as many obtained it from their neighbors. It is possible that most of the neighbors got their information from corn buyers. Very few farmers obtained their price information from unbiased sources, like the newspapers, radios and municipal agriculturists.

TABLE 19.—*Sources of price information*

SOURCE	PROVINCE						ALL
	Batangas	Isabela	Davao	Cotabato	Cebu	Negros Oriental	
	per cent						
Public market	47	2	1	—	45	49	27
Radio	3	1	1	—	—	—	1
Neighbors	17	8	7	—	35	48	22
Buyers	30	73	64	91	20	3	42
Newspapers	3	5	—	—	—	—	1
FaCoMa	—	—	14	8	—	—	3
Merchants in town	—	3	14	1	—	—	3
Municipal agriculturists	—	8	—	—	—	—	1
Total	100	100	100	100	100	100	100

Marketing costs

In this country where the marketing system is considered underdeveloped, the marketing services performed are few and simple and the marketing costs are low relative to farm prices.

Marketing operations at the farm level were considered to start at the time of harvest. The marketing services performed between the time of harvest and first sale were harvesting, which includes hauling, husking, drying and storing, shelling, packaging and transporting to market (table 20).

TABLE 20.—*Marketing cost per cavan shelled corn*

COST ITEM	CASH/KIND	NON-CASH	TOTAL
		pesos	
I. Harvesting: hauling, husking, drying, and storing			
Family/operator labor	—	0.36	0.36
Animal labor	—	0.11	0.11
Hired labor	0.01	—	0.01
II. Shelling:			
Family/operator labor	—	0.10	0.10
Hired labor	0.07	—	0.07
III. Packaging and selling:			
Family/operator labor	—	0.09	0.09
IV. Transporting to market:			
Family/operator labor	—	0.03	0.03
Hired labor	0.03	—	0.03
Total cost	0.11	0.69	0.80
Average price received per cavan shelled corn			0.08
Net farm price			7.28

The cost of marketing a cavan of shelled corn by farmers averaged ₱0.80. Of the major cost items, harvesting constituted 60 per cent of the total marketing cost incurred by farmers. The second major cost item was shelling which represented 21 per cent of the total cost. Expenses for transporting corn to market amounted to only eight per cent of the total expenditures.

The marketing costs were classified into cash or kind and non-cash expenses. The non-cash costs constituted ₱0.69 or about 86 per cent of the total and the cash or kind cost was ₱0.11 or 14 per

cent of the aggregate expenses. Family or operator labor used for harvesting, hauling, husking, drying and storing constituted 52 per cent of the total non-cash cost. The second big item, which was about 16 per cent of the total non-cash cost represented charges for the use of carabao in hauling corn from the field to the farmer's barns. The third largest item, constituting about 14 per cent of the total non-cash cost, was family or operator labor charges for shelling. Of the cash or kind cost items, hired labor utilized in shelling made up 64 per cent of the total cash or kind expenses.

For all provinces, the average price received per cavan of shelled corn was ₱8.08. The total cost of marketing a cavan of shelled corn by farmers subtracted from the average price of ₱8.08 gave a net farm price of ₱7.28.

The cost of transporting a cavan of shelled corn to market was directly related to distance but inversely related to volume transported or marketed (table 21). As distance increased the cost of transportation likewise increased. A cavan of corn transported less than 5.5 kilometers cost ₱0.14; 5.5 to 10 kilometers, ₱0.20 and 10.5 kilometers and more, ₱1.84.

TABLE 21.—*Cost of hired transportation by distance in 47 corn farms* [a]

DISTANCE IN KILOMETERS	AVERAGE DISTANCE	NUMBER OF TRIPS	VOLUME SOLD	COST PER CAVAN
	kms.		*cavans shelled corn*	*pesos*
Less than 5.5	3.0	2.6	57.2	0.14
5.5–10.0	6.7	2.0	21.8	0.20
10.5 and more	10.5	5.8	5.2	1.84

[a] Includes Batangas, Isabela, Davao and Negros Oriental.

The inverse relation of volume of corn sold to distance indicated that the heavy production areas were located near the market centers and that production areas far from the market were characterized by small farms. This was especially true in Negros Oriental.

Table 22 shows that transporting a cavan of shelled corn from the production areas to market centers by motor vehicle was more economical than by animal-drawn cart and hired men. A cavan of shelled corn transported to market by motor vehicle cost ₱0.13; by animal drawn cart, ₱0.63 and by man, ₱1.84.

TABLE 22.—*Cost of hired transportation by kind in 47 corn farms* [a]

KIND OF TRANSPORTATION	NUMBER OF FARMS REPORTING	NUMBER OF TRIPS	APPROXIMATE DISTANCE	VOLUME SOLD	COST PER CAVAN
			kms.	*cavans shelled corn*	*pesos*
Motor vehicle	14	2.6	2.0	48.5	0.14
Animal-drawn cart	2	3.0	2.5	11.5	0.63
Manpower	31	5.8	10.5	5.2	1.84

[a] Includes Batangas, Isabela, Davao and Negros Oriental.

The table shows two important things. First, motor vehicles were the most important means of transporting corn from the farms to the markets, as shown by the fact that the largest volume of corn was transported by motor vehicle. The second implication was that motor vehicles operated only in larger production areas which were near the market. Less corn was sold and the means of transporting corn became more crude as the distance between the production and the market areas widened. These observations imply that better roads which enable transportation facilities to operate efficiently could be a factor in inducing higher production and better marketing of corn.

The most important marketing problem reported by corn farmers concerned prices. Many farmers felt that prices were widely influenced by buyers and expressed a desire for a stronger cooperative action in financing the marketing of corn crops. The lack of credit from other sources forced many farmers to borrow from the corn buyers. This situation places farmers in a poor bargaining position and limits their use of alternative market outlets.

Fluctuating prices within the year was mentioned as another problem. Only a controlled storage program can materially reduce this situation. Financial difficulties force most farmers to sell at or near harvest time; hence they lose the opportunity of getting better prices through storage.

The lack of storage facilities that will protect the corn from damage by rodents and insects is a serious problem in Batangas, Isabela and Davao provinces. Good storage facilities might encourage farmers to store more of their corn before selling it.

Other marketing problems were (1) lack of reliable information on market prices, (2) lack of uniform weights and measures for the sale of corn, (3) absence of good farm-to-market roads which limits the transportation facilities that can be used and increases marketing costs, and (4) need for shelling machines.

* * *

Top priority should be given to more support, sympathy, appreciation, nad better social recognition for basic scientific research. Basic science is concerned with getting verifiable information about ourselves and our environment.

It is essential then to analyze and to interpret this scientific knowledge freely for the benefit of the peoples of the world. This is a major scientific problem confronting us, dealing with the essentials of information, theory and of effective communication. We have to translate what science is about and what it is doing to our people in the language that they can understand.

—Chauncey D. Leake

CROSSING THE COMMON AND SCARLET BEAN (*PHASEOLUS* SPP.) WITH VIGNA SPECIES

F. B. Ballon and T. L. York

The study was undertaken to explore the possibility of hybridizing sitao (*Vigna sesquipedalis* Fruwith) and cowpea (*V. sinensis* Savi) with Scarlet Runner (*Phaseolus coccineus* Linn.) and Kentucky Wonder and Bountiful (*P. vulgaris* Linn.). The native varieties of sitao used were "Sitao na puti" (Singapore sitao), "sitao na pula," ACS (a hybrid between the Alabama Crowder variety of cowpea × Singapore sitao) and BCS (a hybrid between the Brown Crowder variety of cowpea × Singapore sitao). The main objective of the study was to produce a hybrid which would combine the good flavor and the high pod production of *Phaseolus* with the succulent pod character of the *Vigna*.

Technique of crossing. Flower buds of Vigna which showed no sign of pollen dehiscence were emasculated at 4 to 6 o'clock in the afternoon. The bud was held between the thumb and the forefinger with the keel side uppermost. A needle was run along the ridge where the two edges of the standard petal unite. The wing petal was pulled downward exposing the keel. A slit was made in the keel, approximately three millimeters below the stigma. The ten stamens were then removed with a pair of pointed forceps. The disturbed portions of keel, wings, and standard were returned to their original positions. These were then enclosed in a gelatin capsule.

The emasculated flowers were pollinated at 6 to 7 o'clock the following morning. A pollen-laden stamen from a freshly-opened Phaseolus flower was quickly rubbed on the stigma of the Vigna flower.

Technique of staining pollen-tube. The 48-hour-old artificially-pollinated pistils were slit along two sides, scalded from 30 seconds to two minutes in hot water (70-75°C.) and then immersed for several hours in an ethyl alcohol-formalin solution (50 cc. of 50 per cent alcohol and 6 cc. of 6 per cent formalin). Within 12 hours of killing, the styles were dissected with fine needles and forceps under a stereo-binocular microscope. The entire style was placed on a glass slide and by means of two very fine needles was split longitudinally

along one side of the central canal. The cut surfaces were spread apart until they lay flat on the slide. In removing the cortex from the style and stigma, care was taken to keep the aggregation of pollen tubes and conducting tissue intact. The strand of conducting tissue was stained within 24 hours of dissection in a watch glass containing a mixture of one part one per cent alcoholic light-green stain to seven parts water. The tissue was left in the staining solution for 12 hours after which it was washed and mounted in 80 per cent lactic acid.

Pollination on outside planting. Inspite of the many pollinations made, no hybrid plants were obtained. Occasionally, pods remained on the mother plant up to maturity; but in all cases, genetic markers proved that plants grown from such pods were definitely of the maternal parent (*Vigna* type). Obviously, pollination through insects must have taken place.

Growth of Phaseolus pollen tubes in Vigna styles. More than 2,045 stigmas of the female parents used in the greenhouse experiment were pollinated. These styles were dissected and the pollen tube which had undergone the longest development was measured by a micrometer.

In order to have a criterion of length of normal pollen tubes in sitao styles, selfing of sitao was made. It was found that pollen tubes in such material reached the ovule six hours after pollination. In sitao × Scarlet Runner, sitao × Kentucky Wonder, sitao × Bountiful and (Alabama Crowder Cowpea × Singapore) F_1 × Bountiful there was a distinctly slower growth of the pollen tube, on the average reaching about half the length of the style in six hours.

There was a retardation of the growth rate of pollen tube from the first to the second hour and from the second to the third two-hour interval. The *Vigna* pollen growth rate increased whereas the *Phaseolus* pollen growth rate was retarded. This retardation might have been due to the high temperature at noon, which coincided with the end of the six-hour interval. An ovarian secretion might also have been responsible for retarding growth of pollen tube in the style. Only one or two pollen tubes developed in the style of the *Vigna* × *Phaseolus* species, whereas, in *Vigna* × *Vigna* varieties several pollen tubes grew inside the style.

In sitao × sitao, the average growth of pollen tubes in the six-hour interval after pollination was 11.614 mm. Sitao × Kentucky Wonder averaged 6.33 mm., ACS × B, 6.13 mm.; BSC × SR, 612 mm.; and BCS × Kentucky Wonder, 6.030 mm.

INDEX TO VOLUME XLII

ABARIENTOS, E. P.,303-318
Abelmoschus esculentus (L.) Moench., 264-266
Aerial photogrammetry, some applications in agriculture, 1-5
AGLIBUT, ANDRES P., 267-277; 358-363
ALICBUSAN, ROMEO V., 264-266; 319-322
Anthracnose of corn, 250-263
Anti-oxidant Ionol-CP, 134-140
ARGAÑOSA, V. G., 73-78
Avocado, seedless, mutant forms among Philippine plants, 194-195

Bacterial blight of rice, 115-128
BAGUILAT, TEODORO B., 18-35
BALLESTEROS, ONOFRE *Q.*, 231-249
BALLON, F. B., 454-455
BANAAG, A. F., 163-172
Berkjala, estimating liveweights of, 142-144
Berkshire swine, heart beat, respiration and body temperature of, 37
BERNARDO, FERNANDO A., 129-133; 141; 323-324
Biochemical studies on abacá mosaic and bunchy-top viruses: III. Organic acid and mosaic virus infection, 129-133
BUI VAN TRO, 79-85

CADIZ, T. G., 70-72; 196-197
CALMA, V. C., 404-413
CANONERO, E. C., 196-197
CARANGAL, APOLINARIO R., 129-133
CATAMBAY, A. B., 358-363
CLAMOHOY, L. L., 73-78
Coconut farmers in Calolbon, Catanduanes, 222-230
Coffee, four diseases hitherto undescribed in the Philippines, 292-302
Corn, anthracnose of, 250-263
Corn-and-cob meal in a ration for laying hens, 110
CORTES, F. L., 110
Crossing the Common and Scarlet Bean (Phaseolus SPP.) with Vigna Species, 454-455

DANO, P. L., JR., 86-92
DELFINADO, MERCEDES, 345-357
Desmodium intortum (Mill.) Urb.,
Effect of, management on incomes of rice farmers, 173-189; underdrainage on yield of corn and rate of drop of water table, 86-92; two quantities of grains in milk production, 79-85; continuous submergence on various depths of irrigation water on the growth and yield of lowland rice, 358-363; spacing upon the yield of Tick Clover (*Desmodium intortum* [Mill.] Urb.), 404-413

Estimating rice production by using three sampling units, 210-221
EUSEBIO, J. A., 142-144
EVERETT, H. L., 6-11
Farm business management of coconut farms, 374-389
Farm management study in Duc-Hoa, Long-An, Vietnam, 93-108
Fertilizer and plant spacing test on sitao, 196-197

FRONDA, F. M., 110; 325-335
FUENTE, R. K. DE LA, 12-17

GALVEZ, N. L., 49-59; 281-291
GIBE, L. N., 190-193
GRAY, H. E., 358-363
Growth of rice plants in nutrient culture, 145-162
GUZMAN, L. P. DE, 173-189
GUZMAN, MOISES DE, 37

HOGAN, T. T., 336-344
HOLASO, ALICE A., 145-162

Inert dusts for the control of storage insects of shelled corn, 414-422
Insecticides and cover-cropping and their bearing on the control of abacá mosaic, a field test on the use of, 364-373
Irish potato varieties in San Mateo, Rizal, a study of, 70-72

LABADAN, R. M., 414-422; 423-430
Lactating does, two rations for, 73-78
LOPEZ, AMELIA B., 281-291

Mango, diplodia rot of, 319-322
MANNI, M., 336-344
MANZANILLA, ELVIRA B., 36
MARASIGAN, J. M., 374-389
Marketing corn at the farm level in the Philippines, 431-453
MATTHYSSE, J. G., 364-373
Multiple fertilization in maize, 6-11
Mutant forms among Philippine plants, notes on: I. A case of green santol (*Sandoricum koetjape* Merr.), 141; II. Seedless avocado (*Persea americana* Mill.), 194-195; III. Plicate-leafed coconut tree, 323-324

Naric warehouses in Luzon with reference to the control of stored grain insects, a survey of, 423-430
Nitrogen consumption: An index of agricultural development in Asian countries, 278-280

Okra, cercospora disease of, 264-266
OPPENFELD, H. VON, 173-189; 278-280
ORDOVEZA, J. L., 86-92; 358-363
ORILLO, F. T., 292-302
ORTIGAS, R. Z., 134-140
Oryza sativa L., 391-403

PALAD, O. A., 73-78
PAYSON, R. M., 60-69
PEREDO, BENJAMIN D., 431-453
Persea americana Mill., 194-195
PHAN CONG CAN, 93-108
Plaster board from sugar cane bagasse, the preparation and physical properties of, 201-209
PORDESIMO, AGUSTIN N., 115-128
Poultry farm management and marketing, some aspects of, 303-318
Poultry industry of Thailand, 325-335
Problems of rice processing, an international approach to, 336-344

QUEBRAL, F. C., 190-193; 250-263
QUINTANA, E. U., 173-189; 374-389

RAMOS, MARIANO B. DE, 210-221
RANIT, G. O., 39-48; 134-140
Rations for growing chicks, a nutritional evaluation, 39-48
REYES, BASILIO N. DE LOS, 111-114; 374-389
Rice culture in Italy and Spain, 267-277
Rice stem borer parasites in Rizal, Laguna, and Pangasinan, 345-357
Roxas, Manuel Luz, 198-200

Sample rice production statistics of selected types of culture in the Philippines, 111-114
Sandoricum koetjape Merr., 141
SANDOVAL, P. R., 303-318
SANTELICES, JULIAN B., 222-230
SANTOS, F. I., 404-413
SANTOS, I. S., 6-11
SCHAFER, L. A., 319-322
SELIRIO, BENEDICTO, 1-5
Shoot apex of *Oryza sativa* L., zonal structure of, 391-403
Soil fertility-corn population test in northern and southern Luzon provinces, 49-59
Storage factors on the milling recovery of Milfor 6(2), a study of, 70-72
Supplementing Anti-oxidant Ionol-CP (2 - 6-DI - TERTIARY - BUTYL-P-CRESOL) to a brooding ration for chicks, 134-140
Swine feeding and nutrition, 109
S_2 College White Flint and S_3 Bicol White Flint inbred lines, general and specific combining ability of, 231-249

TANTENGCO, PASCUAL T., JR., 201-209
The mineralization of the organic mat-

ter of some Philippine soils under submerged conditions, 281-291
TUCAY, ERLINDA A., 129-133
Two sorghum diseases in the Philippines, occurrence of, 190-193

UICHANCO, L. B., i; 198-200
UMALI, D. L., 141; 194-195; 323-324

VALDEZ, R. B., 292-302
VALERA, F. O., 404-413
VELASCO, J. R., 12-17; 145-162
VIADO, G. B., 163-172
VILLEGAS, VALENTE, 38; 109

YLAGAN, M. M., 134-140
YNALVEZ, LAURO A., 36
YORK, THOMAS LENOIR, ii
YORK, T. L., 454-455

ZAMORA, PRESCILLANO M., 391-403